PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

OCTOBER 1957

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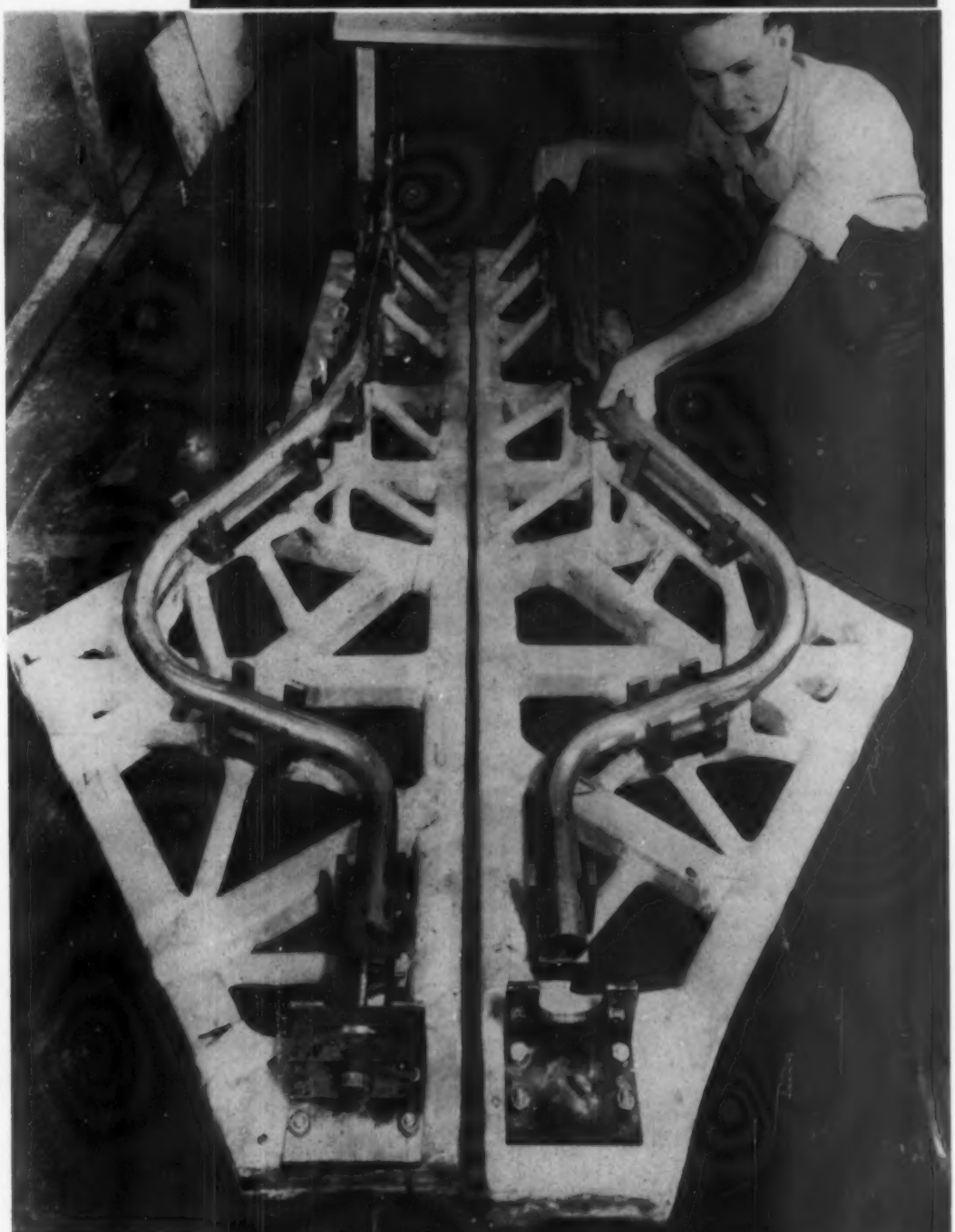

REINFORCED-EPOXY CHECKING FIXTURE GAGES

BENDS IN AUTO TAIL PIPE

See Feature Story/page 808

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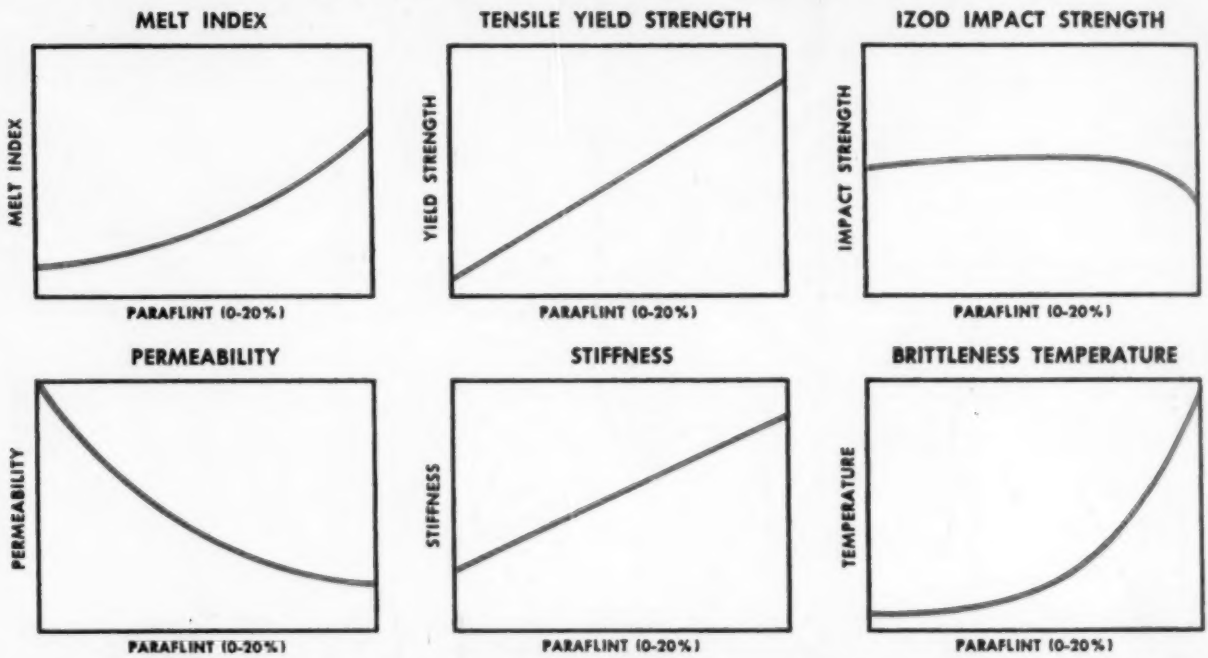

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

OCTOBER 1957 VOLUME III NUMBER 10

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Cover photo courtesy: Bakelite Company

PUBLISHED MONTHLY BY
Plastics Technology Publishing Corp., a Division of
BILL BROTHERS PUBLISHING CORPORATION
386 FOURTH AVENUE, NEW YORK 16, N. Y.

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Article

Highlights

Polyester Premix Molding Compounds. (p. 805)

Premix molding offers two major advantages over mat or preform molding techniques: lower costs in terms of materials and production time, and greater flexibility in the molding of complex and intricate parts. A certain amount of part strength is lost, however.

•

Method of Evaluating Polyethylene Molding Compounds. (p. 809)

The various polyethylenes are classified readily by their density and melt index. Methods are presented here for classifying them as to end-product quality and processibility. Factors considered include ease of flow, cycle time, and surface appearance of moldings.

•

Embedment, Potting, and Encapsulating Processes. (p. 814)

Resin-filler-catalyst systems are discussed, along with embedment material systems, tools and fixtures, potting operations, molds, process equipment, and the like.

•

New Fabrication Techniques for Flush Circuitry. (p. 819)

Within the broad classification of printed circuits is a specialty class known as flush circuits, where the surface of the conductor is coplanar with the surface of the dielectric material. This article covers two fabricating methods for making single- and dual-sided, laminate-type flush circuits.

Previews

The following articles will be published in the November issue:

Causes and Control of Calender Roll Plating of Vinyl Compounds. L. G. Howard, development engineer, and R. C. Hess, group leader, Calendered Film & Sheeting Products, Bakelite Co., Bound Brook, N. J.

Cycolac in Rigid Thermoplastic Piping. H. H. Irwin, technical director, and R. K. Multer (now vp, Architectural Tiling Co.), Marbon Chemical Division, Borg-Warner Corp.

High-Speed Tensile Tests of Thermoplastics. R. E. Ely, rsch. engineer, Ordnance Missile Labs, Redstone Arsenal, Huntsville, Ala.

Reinforced Plastics in Boat Hull Construction—Part I. R. J. Della Rocca, asst. eng., design development, Gibbs & Cox, Inc., New York, N. Y.

Letters to the Editor

Wants Article Reprints

Dear Sir:

We have encountered difficulties in obtaining reprints of articles abstracted in your "Abstracts of Important Articles" column. Perhaps you might set up a copy service at a nominal charge.

C. J. Harris
Detroit, Mich.

(We thought our readers might be interested in this letter. Actually, most business magazines have one or two exchange subscriptions with corollary publications. If foreign, they are translated by the foreign editor. We ourselves cannot give out what is probably our only copy for the files. We do list the addresses of the magazines we abstract once every three months. In addition to the costs involved, it would be impossible to predict the demands for any given article.—Editor)

• • •

Engineering Case Book

Dear Sir:

I was very much interested in your editorial of August, 1957, specifically, your reference to the need for a "real engineering case book."

While the lack of complete information is true for the bulk of materials, recent developments show that at least one supplier, Du Pont, is attempting to do something about it.

In a recently published handbook for design engineers, "Designing with Du Pont Plastics," property data covering a full range of conditions is presented. A special section, "Application Design," adds case history material plus chapters on designing gears and bearings.

Charles S. Booz
E. I. du Pont de Nemours
Wilmington, Del.

(More will be said about this book in a forthcoming issue.—Editor)

• • •

Doesn't Like Magazine Size

Dear Sir:

Why don't you use standard magazine size? It would make filing of articles and/or issues much easier.

Dr. A. Simmonds
Oak Ridge, Tenn.

(This is both an interesting and curious question. Interesting—because we want to supply what you, the reader, wants; curious, because our size (8¼ x 11¼) is considered standard size. In printers parlance there is standard size, folio size, king size, and 9 by 12 inches. We would blush to tell you the printer's designation for this latter size. How do our other readers feel?—Editor)

• • •

Reader Interest Level

Dear Sir:

Presidents, vice presidents, and other plastics men on the executive level have many sources of information—usually the material suppliers themselves.

If you feel your magazine should at least partially fulfill an educational function, why not run articles which are pointed at the foremen, sub-foremen, and others actively engaged in plastics processing?

R. S. Dotson
Chicago, Ill.

(We welcome comments on all phases of editorial content. The only ways we can be really sure of what you want to see are your replies to our editorial questionnaire and your letters.—Editor)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

"Quote . . . Unquote"

Adhesives for Vinyls

"With the increasing demand for rigid, semi-rigid, and flexible vinyls in combination with various substrates, the adhesives industry is faced with a multitude of chemical and physical requirements which must be tailored to the numerous laminations possible by the versatile properties of vinyl plastics.

"The adhesives industry has played a major role in recent developments directed towards decorative, structural, and protective mediums which offer a large market for the vinyl industry. To meet the numerous outstanding requirements of the various applications it has been necessary for the adhesive and vinyl processor to mutually appreciate the respective requirements and problems involved.

"In general, the adhesives adaptable for use in conjunction with vinyl laminations involve resinous and modified elastomerics, all of which are formulated with definite properties to meet specific conditions. The resinous formulations are mainly used in rigid laminations where high static load and shear is required, although plasticized versions have a definite place in the vinyl to fabric and vinyl to paper field. The modified elastomerics are exceedingly versatile in adhesion and offer a wide range of fabrication procedures.

"The adhesive industry has taken great strides in recent years and has played an important role in the industrial advancement of the vinyl industry and will continue thorough research to keep pace with the increasing demands for new and more versatile adhesives."

R. C. Lillie, Asst. Ind. Sales Mgr,
Angier Adhesives Division,
Interchemical Corp., New York, N. Y.

• • •

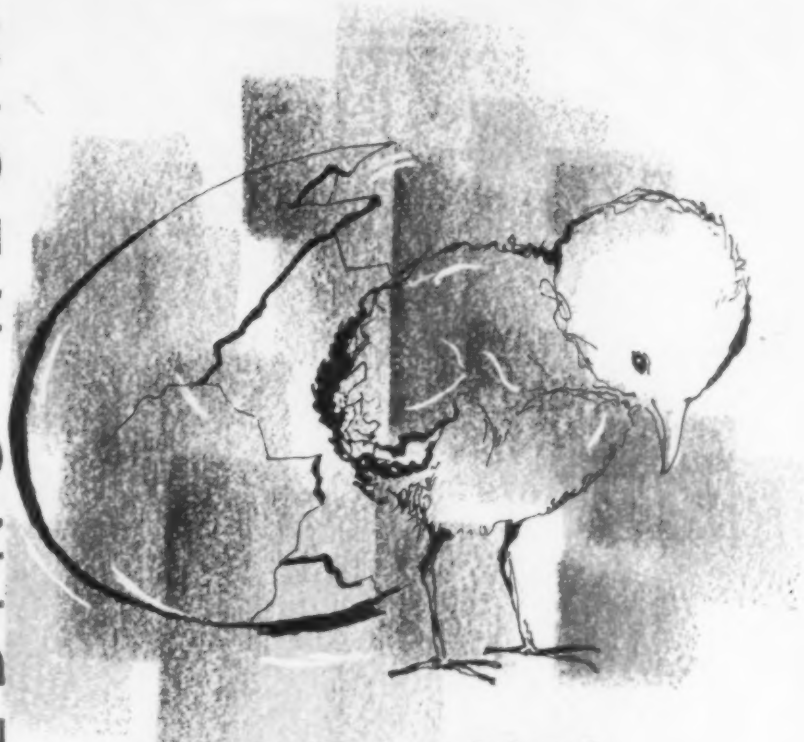
Agricultural Future of Vinyl

"More than 100-million pounds of plastic film have been forecasted for agricultural usage by 1965—some individuals close to the development work now being conducted claim this is a conservative estimate. Over the past few years the progress and development work in this field has been reported . . . Activity has continued and reports of large scale trials are now becoming available . . . American farmers in future years will be as dependent on the plastics industry for our products as we are for theirs."

John Murphy, Tech. Service Mgr.,
Plastics Division, Monsanto Chemical Co.,
Springfield, Massachusetts

• • •

PLENCO SHELL MOLDING RESINS



the shell, dear friend, cannot be lightly dismissed

Cast parts no longer need emerge wearing the pock-marked badge of sand casting.

Shell molding with Plenco phenolic resins has made that rough-hewn appearance obsolete. Now, parts can be cast with smooth surfaces that require little or no polishing. And machining required is negligible, or often even completely unnecessary.

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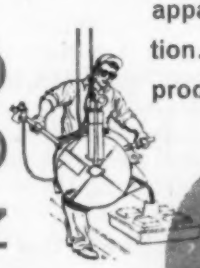

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② **economy**
③ **easy use**

One of these new "Dutch Boy" stabilizers, Flomax* 25 is a barium-cadmium organic. It's the one to give clears, vivid blacks, or colored translucents extraordinary heat and light stability. It contributes extremely high resistance to yellowing and to plateout.

The other, "Dutch Boy" Nalzin*, is an equally remarkable zinc organic co-stabilizer. When stain resistance is a must, Nalzin replaces a portion of the barium-cadmium organic.

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If you make stocks for shower curtains, tablecloths, luggage, upholstery, pocketbooks and the like, get a rundown on Flomax 25 and Nalzin. And on four other "Dutch Boy" non-lead Stabilizers for stocks of this type. Write for the new "Dutch Boy" Stabilizer Handbook.

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NEWS in BRIEF

The multi-million dollar Hi-Fax plant built by Hercules Powder Company in Parlin, N. J., is now in commercial production. First in the U. S. to use the Ziegler process for manufacturing high-density polyethylene, the facility has an estimated capacity of 30-million pounds annually. Both natural and colored materials are presently available.

What the plastics molder really needs to know, if he is to operate at a profit commensurate with his capital investment, is material selection, piece and tool design, tolerances, warpage, shrinkage, reject rates, and set-up costs. Unfortunately, plastics molders are not proportionately as well trained as their counterparts in other industries. So says P. R. Young, chief plastics engineer of Wallace & Tiernan, Inc. (See guest editorial, page 813.)

Over 25,000 feet of rigid PVC pipe, made from B. F. Goodrich's Geon resin, has been installed in the municipal park, San Antonio, Tex. The city's park department plans to install the piping in 30-40 other parks and recreation grounds.

Company developments in the plastics industry saw National Automatic Tool Co. form a plastics machinery division, which will manufacture and market plastics injection molding machines. Greer Industries, Inc. has changed its name to Disogren Industries, Inc., to identify the firm more closely with its new urethane material, Disogren. Raybestos-Manhattan, Inc. has purchased the plant and equipment of Graef Engineering Co. Dayton Rubber Co. and Cadillac Plastic & Chemical Co. have merged, and the latter firm will function as a wholly-independent subsidiary of Dayton. The plastics pipe-fittings firm of E. & A. Sales, Inc. has been purchased by Seamless Rubber Co.

Company expansions in the news this month were again plentiful in number. A second Petrothene plant is being built by National Petrochemicals Corp. near Houston, Tex. Foster Grant Co. will open a nylon 6 plant in Manchester, N. H. A $700,000 expansion of its sales service laboratories at Chesnut Run, Del., has been announced by E. I. du Pont de Nemours & Co. Union Carbide Chemicals Co. has scheduled a technical service laboratory at Tarrytown, N. Y. Modigliani Fibers, Inc. is constructing a production facility in Bremen, O. A polymers lab is being built at Air Reduction Co.'s facilities in Murray Hill, N. J. Plastic Molders Supply Co. is adding production space and equipment to its home office in Fanwood, N. J. The Edmonton, Alta., plant of Canadian Industries, Ltd., is expected to double that firm's polyethylene capacity. A technical service lab has been opened in Bedford. O., by Ferro Chemical Corp. B. F. Goodrich Industrial Products Co. plans to increase its manufacturing and warehousing facilities in Marietta, O.

New Materials to be noted (see pages 836-7): non-bleed azo red pigment; three vinyl stabilizers; epoxy resin curing agent; preform screen lubricant; and a silicone mold-release spray.

New Equipment of interest (see pages 838 and 840): dispenser for epoxies and hardeners; injection molding machine; miniature injection unit; a preform heating unit; replacement heating cylinder; and a plastic film laminating unit.

New Products worthy of mention (see pages 842-4): polyethylene ammunition boxes; high-impact, rigid PVC sheet; vinyl lawn sprinkler; epoxy-ferrite absorbers; transparent acetate stickers; vinyl enamel coating; polyethylene beaker; thermosetting metal putty; vinyl flow-through chamber; teflon beakers; PVC pipe coupling; butyrate buoys; and butyrate-nickel headset.

Pyle-Star-Line Connectors with inserts molded of Resinox 3700 green exceed both military and NEMA requirements. They are compact, light in weight, water-proof, gas-proof, shock-proof, dust-proof.

Resinox 3700

green is the first phenolic type molding material to meet the very exacting Mil-C-5015-B Specifications for connectors. A low water absorption thermosetting material, it has been formulated to meet the critical requirements of ordnance connectors. It offers excellent arc resistance even under the most extreme environmental conditions. Designed for automatic molding, Resinox 3700 green makes possible better connectors at lower unit costs. Its unusual dimensional stability, including less after-shrinkage, plus superior automatic molding performance, means fewer rejects. Components made from this premium grade Monsanto compound possess exceptional electrical properties with improved impact resistance. For complete data on Resinox 3700 (frequently the *only* thermosetting material that can solve a critical electrical problem), write to Monsanto Chemical Company, Plastics Division, Room 1855, Springfield 2, Mass.

MONSANTO

RESINOX: REG. U.S. PAT. OFF.

PLASTICS TECHNOLOGY

OCTOBER, 1957

EDITORIAL: Educating the Plastics Industry

There is a continuing need for education of the plastics industry itself, in addition to the recognized need for educating users of plastics items. The latter program teaches the users what to expect of plastics, and how to handle them properly in use. This, of course, will help reduce the number of misapplications plaguing the plastics market, but the primary cause of these misapplications is in the plastics industry itself. It is here where the greatest need for education exists, and where such education can do the most good. An impartial observer can see many signs where the industry is learning and educating itself, and we can only trust that this education continues.

•

There still are many people in the plastics industry who lack a true understanding of the importance of making products that are engineered to meet the requirements of their applications. Unfortunately, these persons give only lip service to the idea of making engineered products, and are concerned primarily with the making of the lowest quality items that can be sold profitably. Their theme-song, too often, is "If I don't cheapen the product, I will be undersold by my competitors."

There is no gainsaying the importance of price and cost factors in product manufacture, since the best item in the world is not satisfactory if it cannot be sold. The danger is that too much emphasis may be placed on economic factors at the expense of engineering.

An exact balancing point for economic and engineering factors usually cannot be attained. There is an area, however, wherein costs can be lowered and properties reduced progressively without rendering them unsuitable for the application. The point at which these properties become unsuited and inadequate is more clearly defined, but the engineer is at a disadvantage when arguing with non-technically trained management that is interested in keeping costs down and profits up, and prefers not to be convinced of the need for factors that will raise costs. So what can be done?

•

There is no panacea for this problem—a quick and easy solution that will please everyone. Instead, the only remedy is education of the people in the plastics industry as to the proper relative importance of engineering and economic factors. Such a program must be long-range in nature, but must be achieved if the plastics industry is to attain maturity.

A truly mature industry has the responsibility of (1) supplying the best products for specific applications; (2) educating its customers to expect and demand the best; and (3) resisting the impulse to make quick profits because of customer ignorance. All three factors above are interrelated and of equal importance. Educating our customers is not enough if we ourselves have much to learn.

Arthur M. Merrill

Editor

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PLASTICS TECHNOLOGY

Polyester Premix Molding Compounds

Suggestions for formulating and working with the compounds to obtain high-volume production at lower costs.

W. E. WIRSCH, *Mgr. of Polyester Sales, Rohm & Haas Co., Philadelphia, Pa.*

MOLDING with premixes offers two major advantages over mat or preform molding techniques for the high-volume production of molded parts: (1) lower costs, both in production time and materials; and (2) greater flexibility in the shape and complexity of parts which can be molded.

In premix molding, all the ingredients, including the reinforcement, which comprise the molded part are incorporated into a homogenous mixture before they reach the press. Preforms and die-cut mat blanks, thus, are eliminated. Since this also eliminates the usual preliminaries of shaping, handling, and laying-up the mat in the mold, and the related operations of impregnating the mat by brushing or spraying on the resin mixture, the length of the press cycle is reduced by 50% or more. Also, lower-cost reinforcing materials and a greater variety of materials can be used in premix molding compounds. The usual reinforcement is chopped glass fibers which either can be purchased commercially or produced from chopped roving or trimmings. Where lower costs are required, such fibrous materials as sisal and abestos, which cannot be handled normally in mat or preform molding, can be used.

With premix molding, parts having relatively complex forms can be produced conveniently. The molded part need not have a uniform wall thickness. Intricate contours, holes, slots, grooves, lugs, bosses, flanges, and inserts can be molded-in with no special preparation or

William E. Wirsch was born in Lorain, O., in 1919. He attended Ohio University and Case Institute of Technology, receiving a B. S. in Chemical Engineering from the latter in 1942. He joined Rohm & Haas Co. following graduation, and served as a development engineer until 1944. From 1944-1946, he served in the U. S. Navy. He rejoined Rohm & Haas after his military service, and has held his current position of Manager of Polyester Sales for the company since May 1946. Mr. & Mrs. Wirsch and their two children reside in Warrington, Pa.

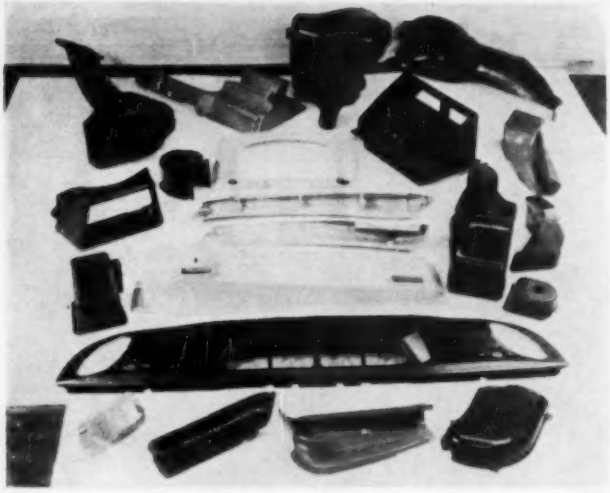


Fig. 1. Some typical parts made by Woodall Industries from sisal- and glass-fiber Paraplex-based premixes. Section thicknesses range from 0.1-0.4 inches.

extra operations. Moreover, since the premix charge can be weighed out accurately in advance for the part being molded, there is less waste and trimming and finishing operations are relatively minor. Figure 1 illustrates the variety of parts produced by premix molding by Woodall Industries, a major fabricator of plastic parts for the automotive and appliance industries.

In addition to high production rates, an important advantage of premix molding, according to Woodall engineers, is that complicated sub-assemblies which formerly were assembled from individual steel stampings, now can be produced as single moldings, thus eliminating most of the former assembling, joining, and finishing costs.

The primary limitation of premix molding is the somewhat low mechanical strength of the molded part; a consequence of the relatively short fiber length which must be used. Short fibers form a random pattern which is not as strong as that obtained with a preform mat in which all the fibers are parellel to the molded surface. Strengths will vary depending on the formulation and type of fiber used. Figure 2 shows these properties of both a typical high- and low-strength premix. It should be noted that the distribution of strength within the molded piece in the high strength formulation is more variable than in the low-strength formulation. Given proper design to compensate for these limitations, however, premix molded parts offer good performance at low cost.

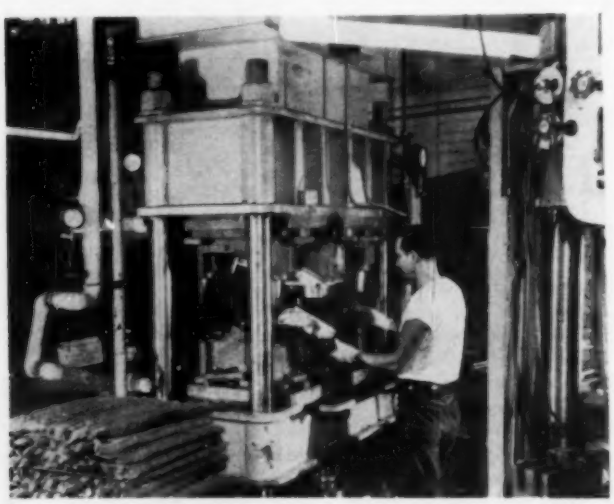


Fig. 3. With premix molding, press can be loaded quickly in a single operation with the premix in a ball or sausage (lower left) shape.

Formulation

A premix compound usually contains the following ingredients: (1) polyester resin; (2) reinforcement; (3) filler; (4) catalyst; (5) pigment; and (6) mold release agent, if needed.

RESIN. The resin has a greater influence on the performance of a premix than it does in preform or mat molding. The resin must serve as a carrier and distribute the filler and reinforcing material to all parts of the mold before gelation occurs. For that reason, it is important to use a resin that retains high viscosity at elevated temperatures. If the resin thins out when heated, it is likely to separate from the fibers, resulting in alternate resin-starved and resin-rich areas, and producing a mottled appearance and appreciable variations in strength. In general, the viscosity should fall in the range of 15-750 poises.

The resin should be fast-curing. Since premixes are generally used for high-production work, a fast-curing resin is important to reduce the press cycle time to a minimum.

The resin also should have good strength at elevated temperatures. Good strength under these conditions permits the molded piece to be removed from the mold soon after the press opens, and eliminates a time-consuming cooling period in the mold that otherwise would be required before the part could be handled without distortion.

Finally, the resin should impart some slight resilience and good impact resistance to the molded piece.

REINFORCEMENT. The type of reinforcing fiber used will depend on the performance required from the part. Since chopped glass fibers produce the highest strength, they are used most commonly. Where strength, particularly flexural strength, is not the prime consideration, however, sisal fibers costing about half as much as glass are the usual choice. Other alternatives are hemp, jute, cotton, and synthetic fibers.

The recommended fiber length for glass is one-half inch. Shorter fibers result in decreased strength, while longer fibers are difficult to disperse uniformly in the premix and do not flow easily, during the molding process, especially into thin sections. Chopped glass fibers of the optimum length can be purchased commercially.

Scrap from random mat, first processed through a hammer mill, is used sometimes, but is not recommended because it is difficult to obtain uniform fiber length.

The glass fibers should be of a type easily wetted by the resin, with silane- or chrome-finished glass being most satisfactory. The concentration limits of glass fiber in the premix ranges from about 10-35%, although

concentrations above 20% cause the premix to become expanded, spongy, and more difficult to preform and flow.

Sisal fibers create a noticeable thread-like pattern on the molded surface which some molders find useful for decorative purposes. Being cellulose fiber, however, they have a higher moisture absorption than does glass, which restricts their use to applications where moisture resistance is not an important property.

The desirable fiber length for sisal ranges from ¼-½ inch. Sisal has a lower density than glass, so that the maximum concentration in premixes usually is limited to 20% to control bulk and facilitate handling. The preferable fiber concentration is 10-15%.

GRANULAR FILLERS. Granular fillers have little effect on the strength of premix molded parts, although they do increase flexural modulus or stiffness appreciably. They contribute to premix molded parts much the same properties as they produce in parts made by other molding processes. These are to reduce shrinkage, prevent crazing or cracking, reduce costs, improve appearance, and adjust specific gravity.

Most fillers are inorganic carbonates or silicates, such as whiting, gypsum, talc, clay and ground limestone; the latter two being the most commonly used. An important factor in the choice of filler is its oil number, which is an index of its oil absorption capacity. Fillers capable of high oil absorption, such as clay, reduce the plasticity of the premix excessively, and necessitate a higher resin content. A desirable filler, therefore, is one that can be used at high concentration without unduly increasing the viscosity and impairing the handling properties of the premix.

Table 1. Granular Fillers for Premix Molding.

	Specific Gravity	Oil Number
Suspenso Whiting	2.68	12
Surfex MM	2.65	19
Snowflake	2.71	22
Atomite	2.71	30
ASP 400	2.58	38
China Clay	2.60	45

Table 1 is a partial list of the granular fillers commonly used in premix molding.

CATALYST. Benzoyl peroxide is the catalyst used most commonly because it imparts good stability to the premix at room temperature, and produces rapid curing at elevated temperatures. The required concentration of catalyst depends on the reactivity and mass of the resin, and to a lesser extent on molding temperature. Catalyst concentrations usually range in the neighborhood of 1% by weight of the resin charge.

PIGMENT. The same pigments and dyes used with other molding techniques are also used in premixes. Up to 3% of pigment paste, based on resin weight, is the usual range.

MOLD RELEASE AGENT. If the premix is properly compounded, a mold release agent may not be necessary if the mold surface is of highly polished chrome plate. If a mold release agent is necessary, however, it can be either applied to the mold surface, or incorporated directly into the compound. Wherever internal lubricants are used, the usual choice is stearic acid for temperatures up to 270° F., and either magnesium or zinc stearate between 270-310° F. Lecithin and silicones are other release agents. The usual concentrations range from 0.1-1% of release agent, based on the weight of the total mix.

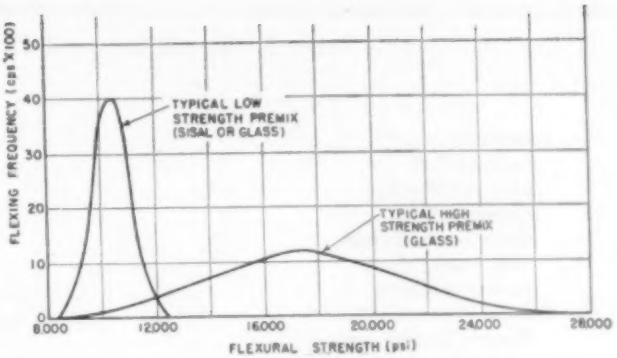


Fig. 2. Distribution of flexural strength within 12-inch square, ⅛-inch thick test panels molded with high- and low-strength polyester premixes.

Preparing the Compound

Premix molded parts can be formulated to fulfill a variety of service and cost requirements. Our plastics laboratories have developed three formulations to guide the molder in compounding premixes for three strength ranges. Paraplex P-47 is suggested because it fulfills the important requirements for polyester resins in premixes: i.e., high viscosity in liquid form; rapid cure; good strength at elevated temperature, and moderate resilience in the cured form. If greater rigidity is required, Paraplex P-49 can be substituted on a 1:1 basis.

Table 2 gives the formulations for the three guidepost premixes. Of course, the concentration of ingredients can be modified to meet individual requirements.

Mixing Equipment

The usual mixing equipment is a double-blade, trough-type kneader fitted with sigma-type or 180° spiral blades. A Minimum of ⅛-inch (and preferably ¼-inch) is recommended for blade-to-blade and blade-to-wall clearance. Horsepower requirements for the drive motor range between 10-15 hp. per 100 pounds or 20 gallons of mixer capacity, based on a premix specific gravity in the grange of 1.7-1.9. The blades should rotate between 25-50 rpm. Excessive blade speeds may cause overheating and degradation of fiber length; insufficient speed retards thorough mixings, and prolongs the mixing cycle.

While the mixing is in progress, the temperature of the batch should be checked occasionally for overheating, since the high viscosity of the mix creates substantial frictional forces. In batches larger than 50-60 pounds, the mixing trough should be jacketed to prevent temperatures from exceeding 120° F. High working temperatures may result in some premature

Table 2. Formulations and Properties of Paraplex Premixes.

	High Strength	Medium Strength	Low Strength
Formulation, %:			
Paraplex P-47	30	33	33
Clay (ASP-400)	35	52	52
Asbestos 7T*	10	—	—
Glass fibers, 1/2-inch	25	15	—
Sisal fibers, 1/2-inch	—	—	15
Benzoyl peroxide	0.30	0.33	0.33
Physical Properties**:			
Flexural strength, psi.	14,700	9,200	5,300
Modulus, x 10^6 psi.	1.5	1.1	0.9
Impact strength, Izod notched, ft.lbs./in.	3.3	1.3	1.2

*Passes 0.053-inch mesh.
**Average of a number of samples from the same test specimen.

gelling and loss of the monomer from the resin.

Mixing Procedure

The first step in mixing is to blend the granular filler, the previously-catalyzed resin, and pigment in the mixer and mix thoroughly for about 10 minutes (or long enough to break up pigment agglomerations). Next, the fibrous filler is added rapidly, but evenly. Uniform dispersion should be completed in about 10-15 minutes. Overmixing must be avoided, since this will reduce fiber length. These times are approximate and should be adjusted for individual conditions.

The completed mix can be either transferred to a drum or bin for storage, or formed immediately into individual charges for use in the mold. If the premix is to be held in storage, it should be kept in a tightly closed and lined container to prevent loss of the monomer. Refrigeration at 45° F. will help extend storage life. The storage life of premixes is variable because of the nature of the ingredients used. Premixes containing certain types of pigments (such as black, blues, or greens) tend to have a lower storage life than those containing other colors. Also, clay is superior to calcium carbonate in this respect.

Molding Conditions

Premix compounds generally require higher-than-normal molding pressure, because all of the ingredients have to flow in the mold cavity, whereas only the liquid resin component flows in mat or preform molding. Molding pressures of 200-700 psi. may be required for premix molding, depending on the size and shape of the part and the type of compound.

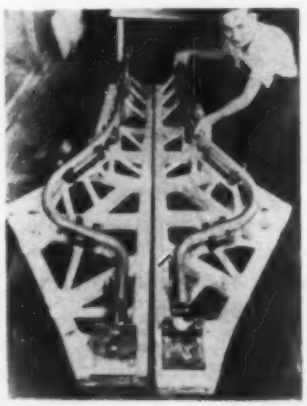
Typical premix molding compounds can be molded in 60 seconds at a molding temperature of 250-300° F. The mold charge generally is predetermined by weighing. Since formulations vary in specific gravity, the weight of charge for each formulation must be predetermined to maintain a fixed volume charge which is constant for all formulations. The charge to the mold frequently is in the shape of a ball or sausage (see Figure 3). One charge centrally placed in the mold usually suffices for most moldings. Because of their shape and size, however, some molds may require several charges spaced appropriately in the mold cavity.

—THE END

Plastic Tooling Solves Problems

Faced with the challenge of rising costs and increased competition, the light metal fabricating industry is turning to plastic tooling as a solution for many of its immediate problems. Arvin Industries, Inc., Columbus, Ind., makes a wide variety of light metal housewares, automotive parts, outdoor furniture, and electronic components, which require the extensive use of prototypes.

Epoxy tooling compounds, based on Bakelite epoxy resins, have provided drastic reductions in both costs and time. Supplied by Mainland Plastic Industries, Inc., Hazel Park, Mich., the materials' close tolerances can be held in fabrication, and their dimensional stability is maintained throughout the life of the tool. Curable at room temperatures, they hold tightly to inserts and bond directly to backing structures.



Epoxy checking fixture for auto tail pipe measures 6-8 feet long, and gages 3-6 precise bends.

Glass-reinforced epoxy forming dies are used in actual production operations, and glass-reinforced epoxy jigs and fixtures are employed for quality control. Epoxy tooling compounds can be cast or laid-up to final shape in one operation. This eliminates many of the conventional finishing and dovetailing steps, with a subsequent saving of 50-70% in tooling time and cost. —THE END

C. S. IMIG, *Senior Staff Member, Plastics Lab., Spencer Chemical Co., Kansas City, Mo.*

Method of Evaluating Polyethylene Molding Compounds

A method is presented for evaluating the compounds on the basis of ease of flow, cycle time, and surface appearances of moldings.

As we learn more and more about the polymerization of ethylene, the number of different polymer types which are available to us increases considerably. These many polymer types may be classified readily by density and melt index to give an indication of the physical properties and ease of flow. We know, however, that more information is required before we can properly characterize them for given end-use applications.

An increasingly important use of polyethylene has been in the injection molding field. It is important, therefore, to be able to perform simple, reliable tests to evaluate the utility of a given resin for injection molding applications. Many factors must be considered by the molder in choosing a particular resin for a job, and these may be divided into two groups; product quality factors, and processibility factors.

Product quality factors include such things as stiffness, impact resistance, strength, and stress crack resistance, in addition to such obvious factors as appearance and contamination. To a great extent, these qualities are built into the resin, but they may be affected profoundly by the manner of molding. For example, parts might be molded from a material with good stress-crack resistance, yet fail consistently because the parts were molded too cold. With a little experience then, we can predict fairly well the properties of the finished part after careful examination of the physical properties reported for the resin.

The processibility factors, however, are much more elusive and difficult to identify. Materials displaying greater stiffness and higher softening points might be expected to give faster cycle times, since they can be removed from the mold at higher temperatures. In practice, however, it may be found that the material requires longer cycles to prevent warpage or to remove the greater heat required to mold the part. It was felt necessary, therefore, to perfect a method of evaluating a polyethylene molding compound which would be simple to perform and yet give reliable information on the moldability of the resin. Since appearance, minimum cycle time and ease of flow were felt to be of prime importance, the evaluation centered around them. An attempt was made then to relate our findings to the basic polymer properties of melt index and density.

Based on a paper presented at the 13th annual National Technical Conference, Society of the Plastics Engineers, Inc., St. Louis, Mo., Jan. 18, 1957.

Materials and Equipment

All the polyethylenes used in this study were manufactured by Spencer at the Orange, Texas, works on commercial-size equipment, and are representative of production material, not small pilot-plant samples. This is of importance since we then are dealing with materials which can be truly indicative of the material going into the molder's shop.

All the injection molding was done on a four-ounce Reed-Prentice injection molding machine equipped with a mold-open timer to insure reproducible cycle times. Even when the operation was not fully automatic, it was felt that this timer was necessary. The mold-open time was set long enough to insure that the operator could open the gate, remove the shot, and close the gate within this period of time. The cycle times, then, were not the fastest at which the mold could be run, but by keeping this setting constant, it was possible to obtain an accurate indication of the speed at which the materials could be run.

Threshold Temperature

As was mentioned before, good appearance and minimum cycle time are of great importance to the molder. L. Griffiths* reported a way in which these properties might be evaluated. The minimum cylinder temperature required to produce a molding with a good finish was determined, along with the corresponding minimum cycle time for a given machine and mold. We felt that this approach had considerable merit, and modified it to suit our particular equipment and experience.

The evaluation was run using a four-cavity test specimen mold. The four cavities consist of a one-half by one-half by five-inch heat distortion bar; a one-half by one-eighth by five-inch flexural bar; a ⅛-inch thick, two-inch diameter disc; and a ⅛-inch thick, 8½-inch long dog-bone tensile specimen. The mold temperature was maintained at 70° F. with a model 6002 Sterlco mold temperature control unit. An arbitrary cycle time of between 30-40 seconds and an arbitrary cylinder temperature first was chosen.

The material was then run at these conditions, and the minimum pressure required to fill the mold determined. Next, the pressure was increased 1,000 psi. on the material, and the appearance of the disc observed. Then, the cylinder temperature was varied in 25° increments, and the procedure repeated at each new temperature until the minimum temperature required to produce a flaw-free surface was found.

An injection pressure of 1,000 psi. above the minimum required to fill the mold was felt to be a practical minimum operating temperature that would yield a molding free of sink marks. The pressure was kept at a minimum, since it was found that higher injection pressures tended to produce flow marks. After the minimum temperature required to produce a flaw-free surface (called the threshold temperature) had been determined, the plunger-forward and mold-closed times were reduced while the mold-open time was kept constant at 10 seconds until the minimum cycle time consistent with good quality molding was determined. Because of its much greater cross-section, the one-half by one-half by five-inch bar was not considered.

In order to obtain further information and experience with this method, threshold temperatures and minimum cycle times were determined on 10 different materials at three density and four melt index levels. The threshold temperature data obtained is shown in Figure 1, where the threshold temperature is plotted against melt index at the three densities. At 0.917 density, the threshold temperature decreased rather sharply as the melt index increased. At the 0.927 level, the threshold temperature decreased very rapidly as the melt index was raised from 2-8, then rose just slightly as the melt index was increased to 26. In the 0.938 density range, the threshold temperature decreased fairly rapidly to a minimum at a melt index of about eight, then showed a substantial increase as it was raised further to 23.

The minimum cycle times obtained are shown plotted against melt index in Figure 2. These curves seem to follow the same trend as was observed with the threshold temperature, with the cycle time decreasing with increasing melt index at the 0.917 density level, decreasing to a plateau at melt index of eight at 0.927 density, and showing a minimum at the same melt index at 0.938 density.

When considering both the thresbold temperature and minimum cycle time, the 0.927-density material seems to be the best at melt indexes of eight and above, although it seems to have only a slight edge

*L. Griffiths, "Injection Molding of Polyethylene Report No. PLI/5/216/B, Imperial Chemical Industries, Ltd., Plastics Division (Oct. 14, 1955).

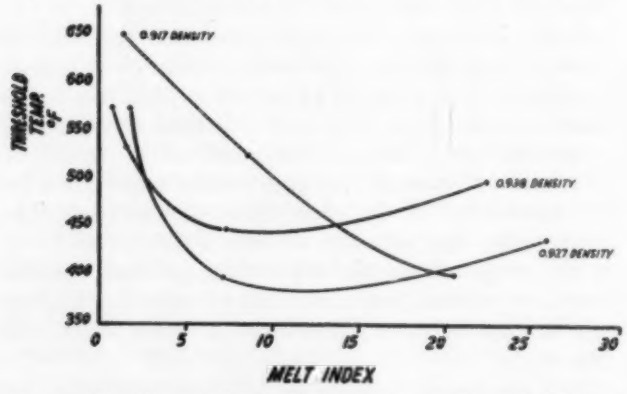


Fig. 1. Variation of threshold temperature with melt index at various densities.

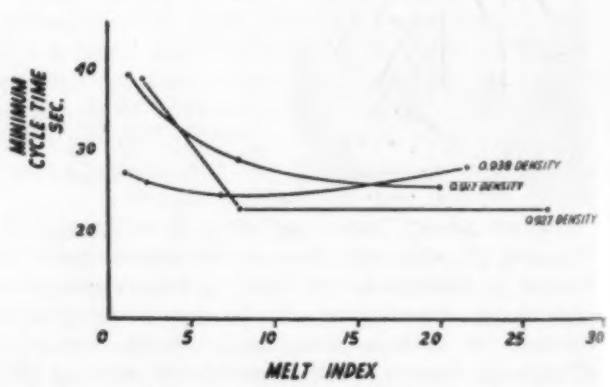


Fig. 2. Variation of cycle time with melt index at various densities.

Fig. 3. Test specimen being molded for spiral mold test.

over the 0.917 material at the high melt index level and the 0.938 material at melt index of eight. At melt indexes of two and below the 0.938-density, materials seem to have a considerable advantage, particularly in cycle time.

Spiral Test Mold

Also of great importance to the molder is the ease of flow of the various materials. Although melt index is a measure of the ease of flow of a particular material, it often is not directly related to the ease of flow in an injection molding operation. This is because of certain basic differences in polymer structure that effect the way the materials behave under the vastly different applied stresses encountered in the melt indexer and the injection molder. Therefore, we must evaluate the flow characteristics at stress levels comparable to those encountered during the molding operation.

We have found that one of the most effective ways to do this is by the use of an experimental spiral test mold (see Figure 3). It consists of a 1⅝ by 0.095-inch channel extending radially from the sprue for 60 inches. In the operation of this mold, a given set of conditions of time, temperature, and pressure are established, and the feed adjusted to give a uniform ⅛-inch cushion. After equilibrium conditions have been

Table I. Evaluation of Flow Characteristics by Spiral Mold Flow.

Density, Gms./Cc.	Melt Index	Spiral Mold Flow Scope	
		At 350° F.	At 500° F.
0.917	1.6	854	570
	8.3	564	366
	22.4	400	266
0.927	2.1	796	536
	8.1	596	388
	26.6	398	274
0.938	0.7	*	700
	2.1	1,018	596
	7.5	700	450
	23.0	580	360

* Too cold

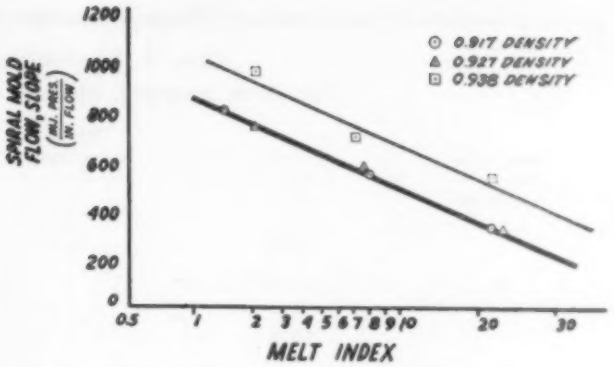


Fig. 4. Variation for spiral mold flow with density at 350° F.

established, sample shots are observed and the length of the spiral taken as a measure of the ease of flow at the given conditions. The same 10 materials of varying density and melt index were used. The mold temperature and the cycle time was kept constant for all the materials in order to eliminate as many variables as possible. The degree of flow was measured for each material at three different pressures, and at cylinder temperatures of 350° and 500° F.

Results of the spiral test mold evaluation are given in Table 1. When the length of the spiral was plotted against injection pressure, a straight line was obtained. The slope (k) of this line may be considered characteristic of the flow behavior of the material over the pressure range studied at the given cylinder temperature. The lower the value for this slope, the better the flow. Obviously, the degree of flow increases at higher melt indexes, higher injection pressures, and higher cylinder temperatures.

In order to have a better picture of the flow properties of a given type of resin, it would be desirable to express the flow behavior independent of melt index. This may be obtained readily by plotting the logarithm of the melt index versus the slope (k). This relationship is shown for the three different density materials in Figure 4 at the 350° F. cylinder temperature. It is of importance to note that the lines for the 0.917 and 0.927 materials are superimposed on one another while the 0.938 density line is parallel and slightly to the right. This indicates that the 0.917 and 0.927 materials have exactly the same flow characteristics, while the 0.938 material has somewhat stiffer flow and may be expected to require higher temperatures and/or pressures.

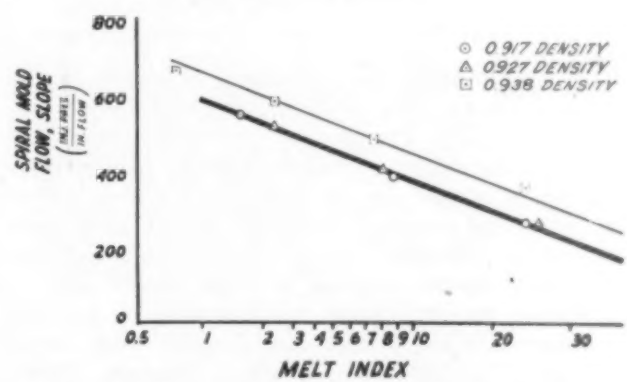


Fig. 5. Variation of spiral mold flow with density at 500° F.

Table 2. Moldability Rating of Polyethylenes.
(For each property, highest number represents the best value.)

Melt Index	Density	Threshold Temp. Rating	Min. Cycle Time Rating	Spiral Mold Flow Rating	Moldability Rating
2 or below	0.917	1	1	3	5
	0.927	2	1	3	6
	0.938	3	3	1	7
8	0.917	1	1	3	5
	0.927	3	3	3	9
	0.938	2	2	1	5
20	0.917	3	2	3	8
	0.927	2	3	3	8
	0.938	1	1	1	3

Figure 5 shows this relationship at the 500° F. cylinder temperature. Again, the 0.917 and 0.927 density lines are superimposed, while the 0.938 density line is parallel and slightly to the right. At this higher temperature, the 0.938 density line is closer to the lower density line, indicating that there is less difference in the flow of these materials at higher temperatures. In other words, the temperature of pressure increase required for the higher density materials will be less at higher cylinder temperatures.

Conclusions

We have outlined a method for the evaluation of polyethylene molding compounds by the combined use of a threshold temperature technique in conjunction with a spiral mold evaluation. It has been demonstrated that the threshold temperature is a useful tool in evaluating polyethylenes within the 0.917-0.938 density range at melt indexes in the entire range commercially available.

This technique demonstrates the minimum cylinder temperature required to produce a flaw-free surface, along with the minimum cycle times at which the material may be run at this temperature. Spiral test mold data was shown to be more realistic than melt index in measuring the flow properties of a material.

In order to interpret the data obtained, we may assign arbitrary numbers to each of the properties of threshold temperature, minimum cycle time, and spiral mold flow properties. If we wish, we can weigh the results by assigning larger numbers to the property of greater interest. If we assume that each property is of equal importance, we may merely assign numbers from one to three for each property, with the larger number representing the best value.

This has been done for the materials we evaluated, and is shown in Table 2. The moldability rating then may be the simple summation of these individual ratings. We can see at a glance which of these materials should be the best molding compound within each particular melt index level. For example, at a melt index of two or below, the 0.938 density material seems superior; at a melt index of eight, the 0.927 density material seems quite superior; and at a melt index of 20, both the 0.917 and 0.927 materials seem comparable and very much superior to the 0.938 material.

We must remember, of course, that we are considering processing factors only, and that the physical properties of the resin also must be considered. However, when several materials exhibit adequate physical properties for a job, the final choice will rest with these processing factors.

—THE END

Postforms Foamed Plastic Sheet

Styrofoam liner is molded in two halves and cemented into reinforced plastic helmet.

A new process for the postforming of foamed plastics sheet stock has been developed by Techniform, Inc., Van Nuys, Calif. The patented process involves a new compression-molding technique, whereby foamed polystyrene or acetate can be shaped into a wide variety of curves and contours. Reportedly, there is no damage to cellular structure; strength factors are maintained at various molded densities; as is the smooth skin.

Among the applications made possible by the new technique are the Rocket Pod frangible nose covers for the U.S. Air Force's Northrop Scorpion F-89H. Molded, foamed polystyrene covers a cluster of seven 2¾-inch air-to-air rockets nested in each of two wingtip pods. On firing, the rockets penetrate each of the seven port areas without ripping the fairing section.

Toptex reinforced-plastic crash helmets for motorcycle policemen required a protective inner-liner which would be light, strong, non-resilient, and conform to the configuration of the existing outer shell. Specially designed tooling, plus Techniform's process, resulted in a liner formed from rigid polystyrene foam. —THE END

The Need for Proper Molder Education

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Wallace & Tiernan, Inc.
Belleville, N. J.

"WANTED: Plastics molding plant operating at a profit," read an advertisement from a recent issue of a national plastics magazine. This advertiser will have few honest replies to his advertisement. There are many plastics molding plants potentially on the market, but few operators can say with a straight face that they are operating at a profit commensurate with their capital investment.

Part of the reason for this, as I see it, is that the people in the plastics molding business are not proportionally as well trained as those in other industries. Most of them were taught the business, the engineering, and the manufacturing methods in the same way most of us were taught to drive cars—by others who really did not know or only had limited knowledge, and were not qualified as teachers. The rest were taught by their own experience. Experience can be a forceful teacher, but all too frequently a narrow-minded one.

The foregoing is not intended to be criticism of anyone or any group, but merely to provide a place to stand from which to make some recommendations for improving the situation.

Since most plastics materials ultimately must be processed by a molder to be sold, all members of the industry—raw material suppliers, equipment manufacturers, molders, as well as publishers—must further the establishment of high school and college courses relating to the molding of plastics.

The number of schools offering courses in the chemistry of plastics is fairly extensive, but there are many long, long steps from the chemistry to the molding of the finished product. What is needed is instruction directed toward the molding characteristics of plastics materials, the design of parts for molding, the design of molds and tools, and the design of molding equipment. The schools also should have some operating molding equipment. Every technical high school and college has machine, foundry, forge, sheet metal, patternmaking and other shops where the students are exposed, at the least, to actual operations. Plastics molding certainly is of sufficient importance to our economy to warrant similar facilities for training as some of the aforementioned.

Since the establishment of adequate schooling facilities is a long-term proposition, at best, the industry publications, in addition to editorially supporting improvement in plastics molding education, can help those of us who will not be able to take advantage of improved educational facilities by frequently publishing articles that tell how to mold something at a reasonable profit.

Such things as material selection, design of the piece for molding, tool design, tolerances, warpage, shrinkage, reject rates, set-up costs, etc., should be covered.

Don't omit them entirely, but limit the space in your magazine devoted to news-type reporting of "blue sky" ideas and developments done with unlimited funds, such as Monsanto's all-plastic house. Such projects should not be decried; they are extremely valuable to the industry in gaining broader acceptance of plastics by the public. However, when you are telling the plastics molder about such things, he really wants to know the design, molding, tooling, material, assembly costs, and other such factors.

—THE END

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Embedment, Potting, and Encapsulating Processes

A discussion of some manufacturing considerations involved in the resin-filler-catalyst system, the tools and fixtures, and the process equipment.

THE widespread use of casting resins for embedment-type applications in recent years has brought about increased knowledge of manufacturing techniques associated with these processes. Of course, this is similar to the evolution of any new art or science, but since the subject processes are relatively new for large-volume manufacturing operations, there remain many areas of uncertainty, as well as many problems with highly controversial solutions. This presents serious manufacturing considerations for the potential large-volume user of these processes.

The simplest solution to known manufacturing problems and the most reliable estimate and solution to potential manufacturing problems are needed by both the manufacturer who is newly entering this type of operation, and the manufacturer who is converting from a beaker-volume to a drum-volume operation. If he is to minimize costly and troublesome pitfalls, he will need to utilize the best ideas which can be obtained from a more experienced user of this type of process. It is in this interest that this paper is presented.

We realize that variations exist in the common usage of the terms "embedment," "potting," "encapsulating," and other similar terms. However, all such terms will be considered together in this paper, since it is really the utilization of low-temperature, low-pressure reacted casting resins in a manufacturing process which is being discussed, no matter what they might be termed.

Resin-Filler-Catalyst System

If the resin-filler-catalyst system has not been decided upon and if the element of time is not presssing, then the choice of the resin-filler-catalyst system can be coordinated with the choice of tools, equipment, and process for the most reliable results. If, as is usually the case, the resin-filler-catalyst system has been predetermined and time is pressing, then the choice of tools, equipment and process is more limited. However, the following considerations should be helpful in either case.

Embedment Material System

Although the general class of resin-filler-catalyst system may be controlled by product requirements, the specific system may not be. Once the screening has been narrowed to a given group of materials, it is desirable from a manufacturing viewpoint to use the system which can be handled most easily. This suggests the following recommendations:

VISCOSITY. Use the lowest viscosity resin that is acceptable. This allows:

(a) Maximum use of filler materials.
(b) Room-temperature compounding.

Based on a paper presented at the 13th annual National Technical Conference, Society of Plastics Engineers, Inc., St. Louis, Mo., Jan. 18, 1957.

(c) More rapid and more thorough wetting and mixing in of the fillers.

(d) Best compound flow properties and, hence, easier mold filling and less chance of air entrapment.

(e) Simpler tool and equipment requirements, since less force and mold opening are required for compound flow, and heat normally is not required.

(f) Better impregnation of parts.

The possible disadvantage here is that the material may flow too freely, thus allowing seepage through mold openings. Seepage can be controlled by the use of fibrous or thixotropic fillers such as milled glass fibers or finely divided silica, a strippable sealant such as a hot-melt thermoplastic material, or closer mold tolerances (see Figure 1).

POT LIFE. Use an acceptable resin-catalyst system with a sufficiently long working life. Quite often, one of the major manufacturing problems comes from using a resin whose working life (or "pot life") is too short. Since pot life is a function of temperature, this problem becomes more acute during hot summer days if temperature is not controlled. A too short pot life makes handling difficult, since resin gelation may take place prematurely. For this same reason, the type of mixing equipment required for a short pot-life material is more critical. Nothing is more troublesome in a volume production operation than to have equipment frozen and, hence, inoperative because of prematurely polymerized material.

There is a limitation, however, as to how long the pot life should be. In general, the longer the pot life, the longer must be the curing cycle or the higher must be the curing temperature. Since the shortest curing cycle and lowest curing temperature are the most economical and efficient, it can be seen that there must be an optimum pot life for every case.

Broadly speaking, a pot life in excess of one hour at the operating temperature usually is sufficient for easy process handling in an embedment application. The maximum pot life for simplest manufacturing practices is not as clear cut, since some resins with many hours of pot life may cure in 2-4 hours at normal curing temperatures. Room-temperature curing cannot be expected of long pot-life materials, however, since the two concepts are incompatible by definition. The maximum usable pot life, then, depends primarily on (1) the curing cycle which can be tolerated, and (2) the polymerization characteristics of the resin.

FILLERS. Use the least abrasive, most easy to disperse, and least likely to settle filler that meets product requirements. Each of these three characteristics deserves thoughtful consideration and, perhaps, the abrasive property of a filler deserves the most thought. An extremely abrasive material like silica will cause rapid wear and degradation of any metal parts through which it is pumped. Similar wear can be expected of cutting and sanding tools used in finishing operations. These facts make the use of abrasive fillers extremely undesirable from the manufacturing viewpoint, since they greatly limit the type of equipment and tools which can be used and increase maintenance costs. The dispersion characteristics of a filler will determine the type of compounding equipment that is required. Fillers that

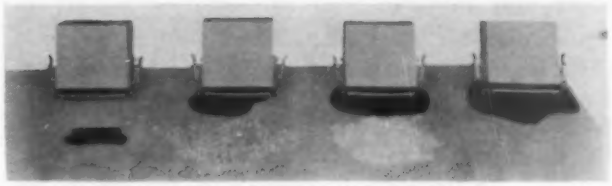


Fig. 1. Seepage control: *(right to left)* Seepage with no control; Seepage when compound is filled with 1% thixotropic filler, by weight; Seepage when compound is filled with 5%, by weight, of milled glass fiber; Absence of seepage when open areas at base of mold ar sealed with hot-melt, strippable sealant.

are easily wetted and dispersed may be compounded in a short time using a simple mixer, while fillers that are difficult to wet and disperse may require several hours of milling in a pebble mill.

With respect to settling, it is obvious that the best filler is the one that stays longest in suspension and, hence, does not need continued stirring to prevent settling. Settling not only unbalances the filler-to-resin ratio, which may be critical, but also increases the chance of whipping and entrapping air in the compound during the continuous mixing.

OTHER COMPOUNDING INGREDIENTS. There are systems that consist of only a single component, and other systems that are multi-component. Perhaps most common is the two-component system; that is, resin and catalyst (or hardener). It is true generally that for most convenient handling, the least number of components represents the best choice. This may not be completely true, however, since a single-component system can be unsatisfactory from some viewpoints, or a multi-component system may be formulated in such a way as to allow handling like a two-component system. At any rate, consideration should be given this point so that the simplest to handle component arrangement is chosen.

Another major question that often comes in formulating a system is how best to tell when the resin (or compound) and catalyst are thoroughly mixed. One of the best ways is to add an unreactive dye to the catalyst, thus allowing an immediate visual indication of the completeness of mixing. In cases where the resin or compound would give a drab color to the dyed mixture, a little titanium dioxide or white color concentrate added to the compound will give sufficient "body" to the compound color and a uniform, pleasing color to the compound-catalyst mixture.

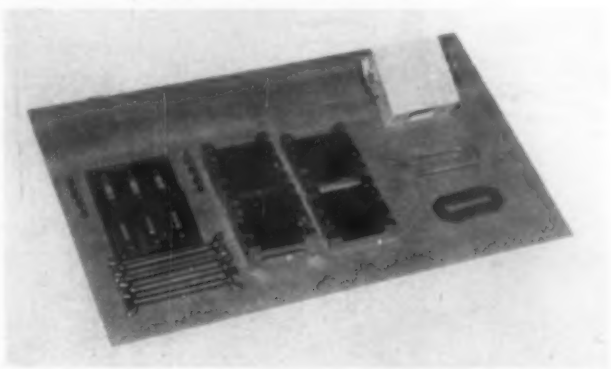


Fig. 2. Three pieces *(right)* in an epoxy mold assembly. Other parts *(left)* are made in a metal mold assembly.

Tools and Fixtures

Normally, the most efficient operation is the one which requires the least amount of tools. This may not be necessarily the least expensive, however, since plastic tooling can be very economical. In some cases, the complexity of the part may make mandatory the use of tools. The following considerations are offered regarding tooling:

Potting Operations

Theoretically, the simplest operation in terms of tools would be a potting operation where a container holding the assembly to be embedded is filled with compound and closed, with no requirements for molds, stripping fixtures, cut-off fixtures, or other special tools. A problem here is determination of the most suitable material for the pot or shell.

The least expensive type would probably be a molded thermoplastic shell. Also, a clear thermoplastic shell would allow observation of the compound surface, if desirable. The limitations of thermoplastic shells are their lack of adhesion to embedment materials in some cases (although a judicious choice of materials can often overcome this), and the fact that they will melt if the curing temperature or reaction exothermic temperature is too high.

The next best choice would be either a metal container or a shell made from a thermosetting resin or laminate. Relative cost and adhesion would be the most important factors to be considered here.

Molds

Molds usually represent the most expensive tools in terms of basic cost, usage, and maintenance. This is particularly true if the part to be embedded is so complicated that a mold consisting of may parts is needed, or if the mold is over-designed (the latter often is the case).

If the part to be embedded adapts itself to a simple mold, then plastic molds should be considered (see Figure 2). This is particularly true where a one-piece mold can be utilized, and also is true in some cases where more parts must be used. Many plastics can be used for making molds, but epoxy resins are among the best because of their low shrinkage and rigidity properties. Dimensional tolerances of 0.001-0.003 inch can be maintained in many cases. This is less than the normal shrinkage of many embedment materials and, hence, generally will be satisfactory.

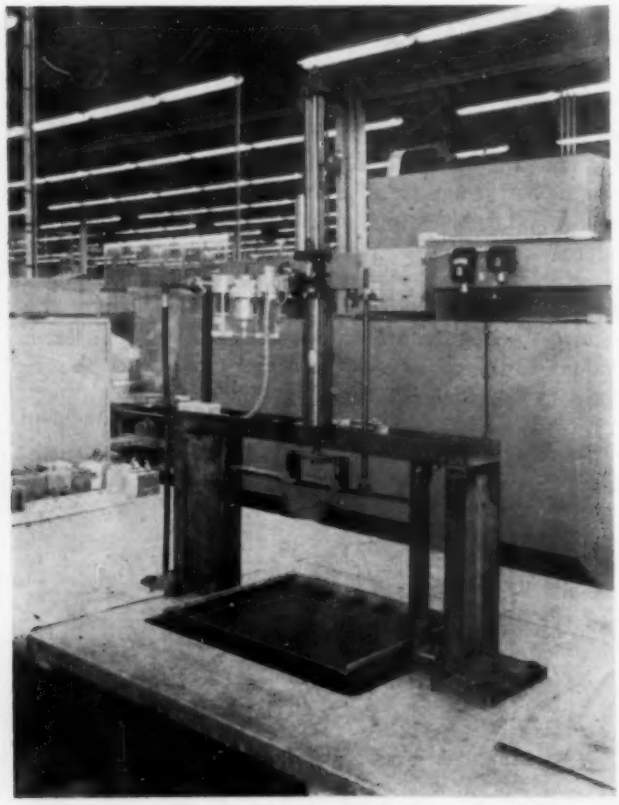


Fig. 3. Apparatus for dip coating molds with a release agent.

Mold Stripping Fixture

Of course, the type of mold used will determine the best type of mold stripping fixture. A simple arbor press can be used for molds which are too complicated, but is not desirable if the mold is complicated or if the production volume is very high. For these conditions, an air-actuated mechanism could be used to advantage. This system, coupled with an automatic feeding, positioning, and product mold-removal arrangement, is very efficient for a large-volume operation. It is more efficient from the mold stripping viewpoint to have a one-part mold equipped with a knock-out ejection pin, than to have a multi-part mold which must be torn down. Since the above-mentioned types of stripping tools are both effective and inexpensive, the use of more complicated fixtures or machines is seldom justified.

Cut-Off Tools

The best choice of tool for cutting off the rough sides of a part will be dictated primarily by the hardness of the embedment resin and the abrasion of the filler material. Rotary cut-off wheels often can be used, unless the filler is sufficiently abrasive to harm the metal cutting edge. Silica is one of the most abrasive fillers and, hence, most deleterious to metal blades. In this case, a diamond-tipped cutting edge must be used.

The cut surface obtained from using a good diamond-tipped cutting edge can be smooth enough to eliminate any additional sanding operations. This is highly desirable, since most abrasive cloths or surfaces tend to become clogged after a short period of use. In some cases, abrasive surfaces are used for the complete cut-off operation, but are not suggested for the above-mentioned reason.

Mold Release Fixture

If a paste or wax-type mold release is used and the mold surface is irregular, a hand-polishing operation may be required. For this reason, the use of this type of release agent is not desirable. In the case of liquid release agents, either an atomizing fixture or a dipping fixture may be used. For uniformity of release on the mold surface, a dipping arrangement with a controlled rate of mold withdrawal probably is best (see Figure 3). This is essential for product surface uniformity if the release agent is somewhat viscous, or if it leaves

run marks on the mold surface. The disadvantage of dipping is that the outside surface of the mold also gets coated with release and, hence, attracts dust and dirt more readily.

If the liquid release has a low enough viscosity and the solvent used is volatile, an atomizer arrangement may be used. However, the surface coating most likely will not be as uniform as a dipped coating.

If the adhesion of the resin is not too great and metal molds are used, a chromeplated surface often will eliminate entirely the need for any release application.

Mold Cleaning Apparatus

Grease and wax can be removed with a spraying or dipping fixture utilizing a suitable solvent, and followed by properly-directed air jets. Naturally, in the case of plastic molds, some solvent that is weak to plastics must be used. If the mold release is very volatile and the release film is very thin, perhaps no between-cycle mold cleaning of this type is required.

In most instances, some flash is left on a mold after each use, and at least some of this flash will have to be removed normally. If the mold has been dipped so that all surfaces are coated with release, tapping with a leather mallet may clean the flash. If this is not possible, then some other cleaning means must be used, since chipping-off is detrimental to molds and, hence, expensive from a maintenance viewpoint.

One type of fixture that has been used sucessfully here is a blasting apparatus employing a soft abrasive, such as corn cob grit, for blasting. For some types of plastic molds, blasting cannot be used because of the lower abrasion resistance of plastics, as compared to metals.

Process Equipment

Since the choice of major equipment (see Figure 4) greatly affects the over-all process cycle length and efficiency, as well as the basic and maintenance costs of the process, much consideration must be given to these items. In any such considerations, it soon becomes apparent that the choice of resin-filler-catalyst system largely controls the type of process equipment desired and, hence, the efficiency and cost of the process. Therefore, as previously stated, process equipment considerations should be among the primary considerations when determing a compounding system.

The following comments are offered regarding the various process equipment items:

Compound Mixing Equipment

There often are considerable differences of opinion as to the proper choice of compound mixing equipment. One viewpoint is that adequate resin-filler mixing is impossible without a lengthy milling operation. The other view is that such complex milling is highly unnecessary, since the desired compound is merely a physically mixed embedment-type compound, and not a surface coating. Each is discussed below.

Milling Equipment

Because of the possible detrimental effects of metal impurities on the insulating medium, the use of pebbles is preferred over metal balls as the grinding media. If extreme care was desired, a ceramic-lined mill could be used. This type of mill is especially desirable for milling compounds loaded with abrasive fillers. Since there is a difference in the abrasion resistances of ceramics, an evaluation would be necessary for choosing the best types of pebbles and liners. Frequent relining of mills is undersirable from many viewpoints.

Milling is usually required for the blending in of difficult-to-wet fillers. It also may be necessary when small concentrations of activators or promoters must be mixed uniformly into a viscous compound whose viscosity cannot be reduced safely by heat. Actually, however, the frictional heat generated in a milling operation often is great enough to require that the mills be cooled by cold-water jackets. For this reason, milling is not recommended if the heat generated might set off the polymerization reaction. This can happen when the resin is heat-reactive and the milling cycle long enough. Difficulties in cleaning out a frozen mill can be imagined easily. Fortunately, most milling of this type can be accomplished in only a few hours thus minimizing the frictional heat generated.

Mixing Tanks

If the filler used is wetted and dispersed easily, and the compound viscosity is low or can be reduced safely by heating, a simple mixing tank probably will be adequate for most requirements. A variable-speed air or electric motor should be used, since resin-filler mixing might require more power or speed than is needed for mere agitation of mixed compound to prevent the filler from settling.

Since most compounds tend to build up on mixing tank walls to which they can adhere, stainless steel tanks or tank liners should be used. Stainless steel also will help to minimize the depositing of metal impurities in the compound. Another good idea for minimizing deposit formations on tank walls is the use of anchor-type stirrers which scrape close to both the sides and bottom of the mixing tank. This same type of stirring arrangement also minimizes filler-settling deposits on the bottom of the tank.

For heating, the use of an electrically-heated oil jacket is probably among the best, and gives both a constant and uniform heat. The tank should be equipped with a glass observation port.

Catalyzing & Dispensing Equipment

Batch Type. If the volume of compound being used is high enough and the pot life of the resin is long enough, a small mixing tank may possibly be used. Some limitations existing in this type of set-up, how-

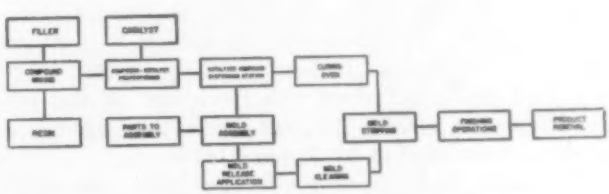


Fig. 4. Flow diagram for process equipment operations.

ever, are:

(a) Catalyst and compound must be added batchwise, giving increased chance for human errors.

(b) Adequacy of catalyst mixing may be questionable.

(c) Temperature is more difficult to control.

(d) Degree of reaction will change from the time that catalyst is mixed in initially to the time that all compound is dispensed; this could be critical.

CONTINUOUS TYPE. From the above, it can be seen that continuous proportioning, catalyzing, and dispensing is to be desired. Since the requirements for accomplishing this vary with the type of system being used, a universally acceptable piece of equipment for this function is not easy to develop. Therefore, extensive experience with respect to equipment needed for a given resin-filler-catalyst system normally is not available. For this reason, specific information is required for specific recommendations.

The following are some general comments which can be made regarding the use of continuous proportioning, catalyzing and dispensing equipment:

(a) Where filler abrasion is a problem, pumping of a filled compound is not practical. The compound should be forced by pressure, and should come in contact with no moving metal parts.

(b) To improve flow and mixing properties, viscosity should be reduced to the lowest practical value.

(c) Either the compound should be dispensed at the fastest practical rate or a long pot-life resin should be used. An automatic alarm, as a function of catalyzed time, should be employed in the system.

(d) The catalyzing chamber should be small as possible to allow maximum compound replacement in the minimum of time.

(e) Adjustments on critical variables should be convenient to make, and positive when set.

(f) Parts coming into contact with catalyzed compound should be attached so as to allow for rapid disassembly in emergencies.

(g) A convenient purging system employing a safe solvent should be available for parts coming into contact with catalyzed compound.

Ideas and costs for accomplishing the above vary widely. Therefore, as many comparisons as possible should be made before deciding on the best method for handling a given compound-filler-catalyst system or deciding if one should be used.

Curing Ovens

If the operation is so organized, a batch-type oven sometimes may be used satisfactorily. For most large-scale operations, however, a conveyor-type oven offers many advantages. The heating is more uniform, since there is no constant opening and closing of doors. Also, the length of the curing cycle is constant and not subject to human error. These are two key variables, since lack of control in either can cause many problems.

Since heat control is so important, the most uniform heat available should be chosen. Circulating hot air, steam or electrically heated, is very good. For best uniformity of heat around the part being cured, the conveyor belt should be of a mesh or roller type, with some air circulation coming up under the belt. A solid insulating-type belt often will cause the base of the part being made to cure unevenly, resulting in serious difficulties. Continuous recording temperature controls should be used for better analysis of any problems which might arise and, in general, for the most convenient control.

Summary

An attempt has been made to discuss briefly some of the more important manufacturing considerations which might be of interest to users or potential users of large-volume embedment, potting, and encapsulating processes. While it is realized that not all aspects have been touched upon and that all the ideas will not be new to everyone, it is hoped that some of the items presented will be of value to some casting resin processors.

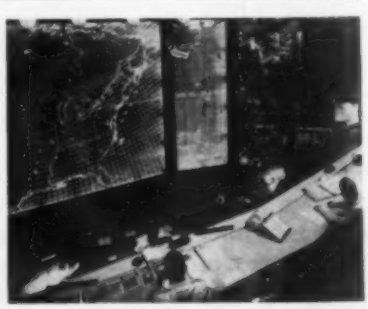
In summary, it should be pointed out that the subject processes are not sufficiently standard to allow a complete list of specific recommendations that would be applicable to all cases. Any manufacturing considerations must be finalized, therefore, by coordinating specific data with general ideas such as are discussed herein.

—THE END

Acrylic Radar-Plotting Board

World's largest radar-plotting board has been designed and erected for the Air Defense Command, Colorado Springs, Colo., by Brooks & Perkins, Inc., Detroit, Mich. The main plotting surface is a single sheet of cast Plexiglas measuring 30 by 19 feet. One-half inch thick, the sheet was fabricated on the job site from eight 100-by 120-inch sheets, the largest size acrylic sheets supplied by Rohm & Haas Co.

The sheets were prepared with butt joints, and bonded with PS-18 cement. The bonds have excellent optical characteristics, and are invisible under normal light. Edge lighting is provided by slimline fluorescent tubes mounted directly on all four edges. This lighting shows the bonds as thin white streaks. Magnesium channels, designed and fabricated by Brooks & Perkins, form the installation's framework and conceal the edge lighting. Total weight is 3,750 pounds. —THE END



Cast-acrylic sheet serves as radar-plotting board.

E. L. DITZ, *Senior Engineer*
and
P. E. RITT, *Chief Chemist*
Melpar, Inc., Falls Church, Va.

New Fabrication Techniques for Flush Circuitry

An investigation is reported of two fabricating methods for making single- and dual-sided laminate-type flush circuits, respectively.

THE production of printed circuits is a relatively new industry that had its birth in the late years of World War II. They first were used in mass production to make a proximity fuse for mortar shells. This occurred in 1945, and its apparent success provided a basis for launching the fabrication of printed circuits as an infant industry. Since that time, it has displayed an astonishing growth rate as well as a tremendous potential. The recent penetration of the consumer markets through the adaptation of automatic assembly processes to home appliances insures that the already lucrative growth rate will continue for some time to come.

The acceptance of printed circuits was not a chance occurrence, but rather the result of continual reports which extolled their merits over conventional wiring methods. To enumerate all of the advantages would require a lengthy list indeed, while a digest of the more important ones would depend entirely upon the specific application. However, one factor which appears in most comparative analyses is the cost advantage resulting from a considerable reduction in manual wiring operations.

Within the broad classification of printed circuits is a specialty class known as flush circuits. These are circuits in which the surface of the conductor and the surface of the dielectric material are coplanar. Such a construction offers a definite advantage for commutator and switching applications. The flush condition permits a wiping contact to pass over the conductor segments without bouncing, thus reducing friction. This, in turn, allows higher operating speeds in low-torque contact arms.

In order to prolong the useful life of a flush circuit, it is desirable to plate the copper conductor with a wear-resistant metal. Gold and silver have found use in this regard, but, to date, the most successful surface is one of rhodium backed by a substrate of nickel. The success of this combination is confirmed by the fact that the life expectancy of a nickel-rhodium flush circuit can be measured in millions of revolutions, with the ultimate value being dependent on such factors as rhodium thickness, brush speed, current in the circuit, and the pressure of the rotating contact. A well-designed flush circuit will compensate for its initial cost because of its low, almost nil, maintenance and replacement costs.

Based on a paper presented originally at the 13th annual National Technical Conference, Society of Plastics Engineers, Inc., St. Louis, Mo., Jan. 17, 1957.

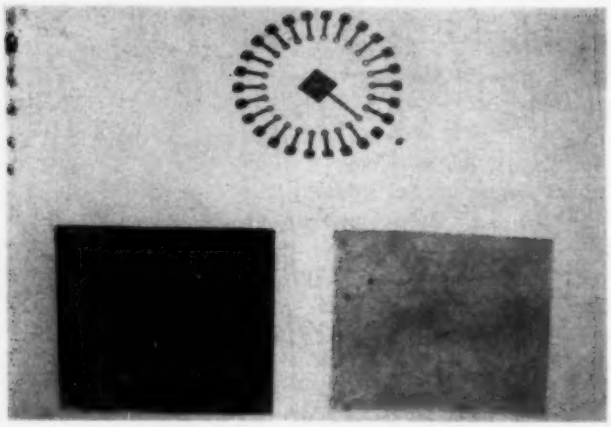


Fig. 1. View of adhesive-backed foil prior to laminating. Shown are both sides of the foil (bottom), and the etched assembly (top).

Flush circuits are available commercially and have been for the past few years, but relatively little has been published on the methods by which they are made. Limited references are made in the descriptive literature of various firms, but these generally are vague. It was the purpose of the work upon which this report is based to devise a detailed process for making both single- and dual-sided flush circuits in small experimental quantities. The scope of the report is limited to a description of the methods considered, together with some of the more important variables which were encountered in their development.

Two methods were investigated as likely possibilities for making flush circuits. One of these involved the use of a copper foil, one side of which was coated with a dry adhesive film. The other method involved the use of stainless steel platens. The former was considered for use in making single-sided circuits, while the latter was devised to produce dual-sided flush circuits with side-to-side registry.

Adhesive Film Method

The use of an adhesive-backed copper foil allowed a circuit to be fabricated from the metallic layer, while the adherent adhesive retained the dimensional configuration of the etched conductors. The etched assembly was laminated then to a quantity of semi-cured XXXP-grade phenolic laminate to produce a single-sided flush circuit.

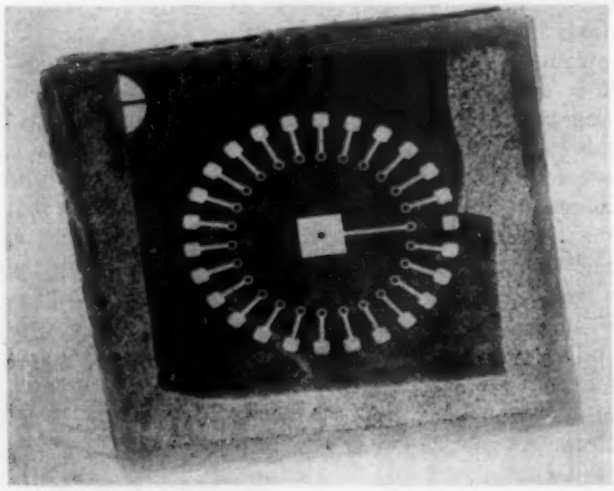


Fig. 2. Flush circuit shown as it emerges from the press.

The adhesive-backed circuitry was fabricated by using a photographic process to supply a plating mask. The cleaned copper surface was coated with Kodak Photo Resist, exposed to a reverse circuit transparency by means of a carbon arc lamp, developed in Kodak Photo Resist Developer, and dried. At this point, in effect, we had applied a mask over the entire copper surface, except in those areas where it was desired to place conductors. Once masked, the unit was plated with 0.0005-inch of nickel followed by 0.000010-0.000020 inch of rhodium. The nickel was plated from Baker & Anderson's fluoborate bath of the following composition and conditions:

Nickel	110 g/l
Boric acid	41 g/l
Nickel fluoborate	420-430 g/l
Saccharine	1 g/l

pH, 3.0
50 ASF
Temp., 60-70° C.
Anodes—Carbon cast nickel

The rhodium was plated from a Sel Rex Corp. bath of the following composition and conditions:

Rhodium	4 g/l
Sulfuric acid, conc.	40 ml/l

Temp., 40° C.
20 ASF
Anode—Platinum

At the completion of plating, the mask was removed and the excess copper etched at room temperature by verticle immersion in a chromic acid bath made up, as follows:

Chromic oxide	560 g/l
Sulfuric acid, conc.	133 ml/l
Water	To 1,000 ml.

After the etching operation, the adhesive assembly was immersed in demineralized water for a period of time equivalent to that spent in the etching bath. This was an attempt to remove some portion of absorbed electrolytes from the adhesive layer. After this, excess water was blotted from the unit, and it was placed between two absorbent blotters under slight, even pressure to dry at 40° C. At the conclusion of this step, the assembly was ready for laminating.

Figure 1 presents a view of the adhesive-backed foil prior to fabrication from both the adhesive and the copper sides, together with the etched assembly. The function of the glue film in retaining the dimensional configuration of the circuit may be noted in the etched assembly. The dark flecks on the glue film resulted from uneven action in the etching bath, and were removed subsequently by localized spot etching with the chromic acid-sulfuric acid solution.

Figure 2 shows a flush circuit as it emerges from the press. It was constructed by laminating the assembly to a sufficient quantity of semi-cured dielectric laminate. To finish the circuit, only routing to size around the circumference of the contact tips and drilling the holes

is required. Due to the small quantities of circuits required for breadboard use, jig drilling was found to be more economical than punching. To date, all of the work with this method has employed the use of XXXP-grade phenolic.

The described procedure represents the ultimate process, and does not take cognizance of the many variables which were encountered along the way. Some of these were as follows:

(1) It was found that application of the photo resist to the foil had to be controlled carefully. Complete immersion of a dipping application resulted in coating both the adhesive and copper layer: Apparently, the resist was not removed completely from the adhesive in the developing step, and this affected the adherence of the conductors to the laminate in the final circuit. It was found that careful pouring of the resist was adequate for coating the copper area without contaminating the adhesive.

(2) Exposure to the developer did not seem to harm the adhesive film for immersion times up to 4 $\pm$ 0.5 minutes. Higher immersion times were found to affect the adhesive, while shorter ones resulted in incomplete developing.

(3) In general, a black dyeing step was included after developing in the Kodak Photo Resist Process in order to discern flaws in the otherwise transparent resist film. It was found that on exposure to the dye, the adhesive and the resist film was dyed black. The dye could not be removed completely from the adhesive, with the result that it imparted an unsightly black color to the finished circuit. Elimination of the dyeing step remedied this problem, and flaws could be detected in the undyed resist film upon close examinations.

(4) In the final drying step after the post etch rinse, it was found necessary that the adhesive assemblies be dried under slight pressure in order to retain dimensional stability. Allowing them to dry in an unrestrained manner caused intolerable warping and curling of the adhesive film which introduced dimensional variations in the finished circuit.

These represent the major obstacles which were encountered in the evolution of the adhesive foil method.

Stainless Steel Platens

Under early consideration as a possible means of making dual-sided flush circuits with side-to-side alignment was a method whereby two single-sided circuits made by the adhesive-backed foil process could be aligned mechanically and bonded back-to-back. After further consideration, this idea was shelved in favor of a process that would produce the desired circuitry on a homogeneous laminate, thereby improving strength characteristics. The stainless steel platen method appeared to offer such a possibility.

The platen method involved a transfer process by which mirror images of the desired circuits were plated onto aligned stainless steel platens, and transferred to a semi-cured dielectric laminate in a temperature-pressure curing operation. The photo resist method was used for applying the masks to the platens that were to be plated, and a special jig was used to achieve alignment.

Fig. 3. Punching the transparencies through alignment holes in the platens.

The actual process consisted of aligning two circuit transparencies so that common contact points were coincident. Positive transparencies were required since the conductors were to be plated. When this was accomplished, the films were taped together to retain the alignment, and then placed between two platens. The latter were keyed to each other by means of alignment pins.

In Figure 3, the operator is shown punching the transparencies through a second pair of alignment holes in the platens. The three smaller pins governed the alignment of the platens with respect to each other. The punching tool was machined to fit the holes in the platens quite closely in order that the holes in the transparencies would match very nearly those in the platens. By this means, the transparencies were keyed to the already-keyed platens, and all segments were in alignment. Next, the entire assembly was dismantled; i.e., the platens were separated, and the tape removed from the transparencies. This is shown in Figure 4.

The transparencies were removed, the platens were coated with photo resist, and each transparency was repositioned with its respective platen by aligning the appropriate holes. The platen alignment holes were taped at this point in the operation in order to prevent plated metals from depositing on the inside diameters. Such an occurrence would have seriously affected the alignment of the platens.

Figure 5 shows the transparencies being aligned with the platens in preparation for exposure. The pins which

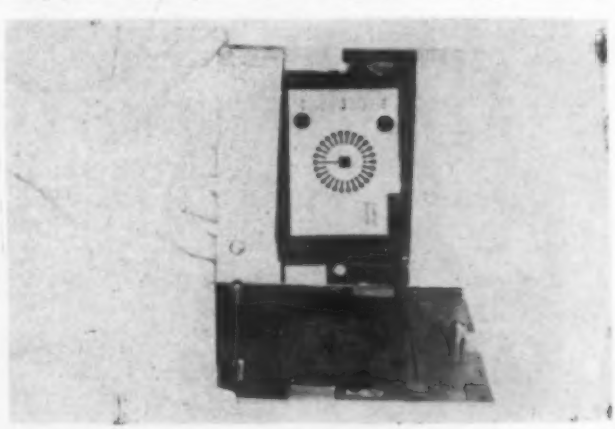


Fig. 4. Dismantled assembly, showing platens separated and tape removed from transparencies.

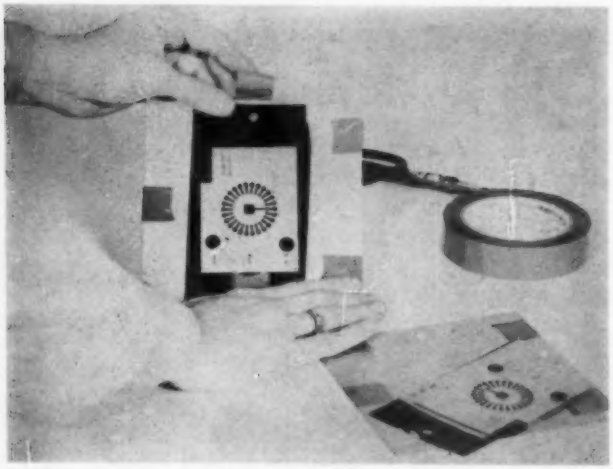


Fig. 5. Transparencies being aligned with the platens prior to exposure.

originally keyed the platens to each other were removable, thus allowing the platens to be exposed in a vacuum frame. The exposure was conducted for two minutes at a distance of 15 inches as measured from the leading edge of the lamp shield to the surface of the glass in the vacuum exposure frame. The exposed platens then were developed in photo resist developer for four minutes.

The masked platens were plated with required metals in the reverse order desired in the finished circuit. This was necessary because the plated conductors were to be transferred to a laminate. For this reason, 0.000020-0.000040 inch of rhodium, 0.0005 inch of nickel, and 0.0013 inch of copper were plated onto the platens in that order. The rhodium and nickel were plated from the same baths under the same conditions as were the adhesive-backed assemblies, while the copper was plated from a Baker & Adamson fluoborate bath of the following concentrations and conditions:

Cooper	50-70 g/l
Cupric fluoborate	210-240 g/l
Borofluoric acid (free)	1.5-6.0 g/l
pH, 0.8-1.7	
50 ASF	
Room temperature	
Anode—Electrolytic copper	

The alignment pins were replaced in the platens after plating, and stop spacers were placed over the pins. The thickness of the spacers was varied depending upon the desired thickness of the finished circuit. The platen without the pins is inverted and placed upon the other platen so that the pins align with the appropriate holes. Then, the assembly is placed in a press where heat and pressure are used to effect final curing. A glue film bonds the circuit to the laminate, and a similar glue film and circuit reside under the stack of laminate material. In this manner, circuits are placed on both sides of the laminate. The spacers on the alignment pins govern the thickness of the final unit.

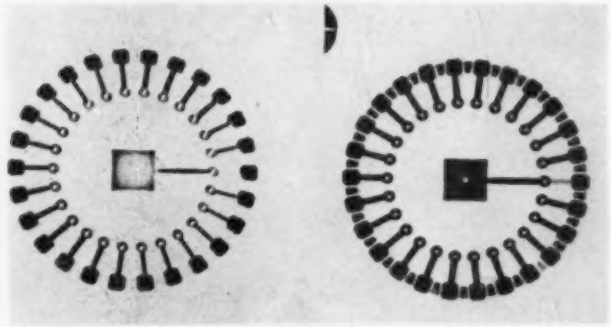


Fig. 6. X-ray photo of two finished circuits taken to check registry.

Both an epoxy-glass laminate and a XXXP-grade phenolic laminate were used successfully in this process. If the plastic laminate contained epoxy resin, no adhesive was required to bond the conductors to the laminate. However, if it involved phenolic resin, an adhesive was necessary. A solvent-activated dry film adhesive was found satisfactory for bonding the conductors to the phenolic laminate. Permacel P-18 adhesive film was used, and was activated by spraying it with a 1:1 acetone-ethyl alcohol mixture. One layer of the treated adhesive was interposed between each face of the phenolic laminate and its adjacent platen. Finally, the platens were assembled and the laminate cured under heat and pressure.

The epoxy laminate was cured at 166° C. for 30 minutes under 100 psi. forming pressure, after an initial gelling period of 4-6 minutes at the same temperature under contact pressure. The phenolic laminate was cured at 160° C. for 30 minutes at 1,500 psi. pressure, after a preliminary warming period of three minutes at the same temperature and 250 psi.

In the case of the phenolic laminate, the adhesive also was cured during this operation. When the curing cycle was completed, the circuit was cooled with full pressure applied. Due to the fact that the bond between the laminate and the conductors was stronger than that between the plated rhodium and the stainless steel, the circuit pattern was transferred to the laminate upon its removal from the platens. Alignment is demonstrated by Figure 6, which is an X-ray photo taken of two finished circuits in order to determine registry. The fuzzy picture is the result of poor alignment (approximately 0.012-inch), while the sharper image represents misalignment to the extent of only 0.005-inch. By careful processing, side-to-side registry as close as 0.005-inch was achieved, while routine handling produced an average nearer 0.010-inch.

In this process, as well as in the adhesive-backed foil program, many difficulties arose during the progress of the investigation. For example, it was necessary to determine the particular stainless steel surface which displayed the optimum qualities of accepting electroplating, yet at the same time maintained a relatively poor bond between itself and the plated layer in order to facilitate the transfer to the laminate.

An electropolished, a mechanically polished, and a 2B mill finish were investigated to determine their suitability to our needs. The electropolished surface would not accept plating at all. While it accepted plating initially, the mechanically polished surface did not retain it through subsequent processing. Only the 2B mill finish provided the desired features and, therefore, was used for the remainder of the investigation.

Another problem arose in the adherence of the plated metal layers, especially at the nickel-copper boundary.

This zone had a tendency to rupture during the pressing operation, thus causing the nickel to peel and leaving the bare copper exposed. This was resolved ultimately by reducing the time between the nickel and copper plating operations to a minimum. The difficulty was traced to a tendency of nickel to accumulate a passive film when standing in air, and this film seriously affected the adherence of the copper. A maximum time limit of one minute was established for transfer from the nickel plating to the copper plating operation in order to restrict the formation of the passive film. By this means, a nickel-copper bond of acceptable quality was obtained.

An extensive search for a mold release which could be applied selectively to the platens, yet not contaminate the conductor areas, was resolved by the discovery that the photo resist mask itself furnishes adequate release. This was found to be true for both the epoxy laminate and the P-18 adhesive surface for phenolic laminates.

The adhesive-backed foil and the plated platen process have proved to be workable methods for making flush circuits on a laboratory scale. This does not imply, however, that they are completely satisfactory. For example, a serious disadvantage of the adhesive foil method is demonstrated by an inability of the nickel-rhodium plating to withstand the chromic acid etch in all instances. Possibly as many as 25-30% of all experimental circuits were ruined in this operation. The use of the platen method circumvented this difficulty in that the conductors were never exposed to an etch in this process.

For this reason, it has proved more practical to make both single- and dual-sided flush circuits by the plated platen process. Our investigation has included little in the way of testing the finished product. Testing, with an eye towards improving the quality of the circuits and the efficiency of the operations, is certainly the next logical step to arriving at final processes. Among the more vulnerable points through which these ends may be accomplished are such variables as platens, adhesives, and laminates.

It is possible that metal other than stainless steel would prove more desirable for use in platens. Then, too, it seems possible that the surface finish of the stainless steel could be defined more specifically. Somewhere between a highly polished surface and a 2B stock finish, there should reside an optimum finish which would retain plated conductors with a minimum of adherence in order that a minimum of stress could be applied to the adhesive bond during the transfer operation.

The investigation of adhesives with an eye towards improving bond strengths also seems a reasonable avenue for progress.

The use of other plastic laminates with the objective of improving strength and wear characteristics also would appear to be a worthwhile investigation. Variations in the resin and the reinforcing material offer possibilities for improving laminates in these desired characteristics.

Conclusions

To summarize the results of the investigation, it can be stated that the specific objective was accomplished; namely, that of finding a method for making flush circuits. No attempt was made to evaluate the commercial feasibility of either process, since the only need was for laboratory quantities. Nothing was encountered, however, which would prevent consideration of either process for commercial use.

As a result of this achievement, it has been estimated that our laboratory facility can deliver such circuits to our engineering groups for experimental use in about one-quarter the time required by commercial suppliers. This estimate includes transaction delays and delivery time, and is restricted necessarily to small lots of 10 or less because of our limited facilities. In addition, a knowledge of the process with its possibilities and limitations has aided our quality control group in composing reasonable specifications for the purchase of flush circuits in larger quantities from commercial suppliers. Finally, we would like to acknowledge that the investigation was conducted under the auspices of the Department of Defense.

This paper is presented in the hope of stimulating further investigations toward improving the techniques of flush circuit fabrication. Such an effect only can speed the day when efficient procedures will be available to all.

Bibliography

(1) Brunetti, C., and Curtis, R. W., "Printed Circuit Technology." **Circular No. 468,** National Bureau of Standards, Washington, D. C. (1947).

(2) "New Advances in Printed Circuits." **Miscellaneous Publication No. 192.** National Bureau of Standards, Washington, D. C. (1948).

(3) "Kodak Photo Resist Manual," **Eastman Kodak Corp.,** Rochester, N. Y. (1954).

(4) "Production of Printed Circuits," **Product Information Bulletin TG-36431,** Baker & Adamson Products, General Chemical Division, Allied Chemical & Dye Corp., New York, N. Y. (1957).

(5) "Plating Stereotypes." **Product Information Bulletin TB-40221.** Ibid (1957).

(6) "Nickel Plating from Fluoborate Solutions." **Product Information Bulletin RC-40221,** Ibid (1957).

(7) "Rhodium Plating Product Information Bulletin," **Sel Rex Corp.,** Newark, N. J. (1956).

—THE END

A sheet of black Visqueen polythylene film covers a loaf-shaped silo, thus ensiling forage harvested within a short distance of the "fermentation chambers." Visqueen is a product of Visking Co., a division of Union Carbide Corp.

The Evolution of Vacuum Forming

A never-ending cycle of complexity and simplicity

Edited by:
E. BOWMAN STRATTON, *President,*
The Auto-Vac Co.,
Bridgeport, Conn.

THE evolution of vacuum forming from an art to an efficient, simple manufacturing process has involved successive cycles of complexity and simplicity. Any custom former with several years' experience in the field can attest to this fluctuation.

The first home-made (and too many of the factory-made) vacuum forming machines began to resemble Rube Goldberg contraptions as their builders added mechanisms and instrumentation to increase the versatility of the process, and to adapt new forming techniques to old machines. Any success in achieving complex manufacturing operations was a signal for the professional design engineer to initiate the reverse cycle—simplifying the machine and making operation automatic, while holding onto the newly-acquired techniques and degrees of manufacturing complexity.

The requirements placed upon the manufacturer of today's vacuum forming equipment include:

(1) Uniform and consistent results at a high production rate. This requires using higher temperatures and more precise temperature control. Heater insulation is mandatory. Clamp frames must be firm, and must adjust easily to the size and thickness of the thermoplastic sheet. Where possible, feeding should be automatic from rolls of plastic.

(2) Material versatility. The machine must be able to handle the ever increasing range of types and sizes of themoplastic sheeting. This involves making a machine with . . . .

(3) Process versatility. The machine must be adaptable to the latest variations of basic technique. Provision must be made for easy change-over from simple cavity forming to draping, male-mold forming, drape assists, plug assists, deep-draw "air cushion" plug forming, and both pressure and vacuum forming.

(4) Product versatility. The ideal general-purpose vacuum forming machine converts easily to handle various materials and modifications of the basic process. This requires design for fast and easy change of mold set ups and clamping frame sizes, plus equally simple adjustment of automatic temperature controls, heating and cooling time, drape height and speed, plug fitting and plug movement, timing of vacuum draw, and air blow-off. In short, controls must be reduced to a minimum and manufacturing cycles must be controlled automatically.

Clearly, the vacuum forming process is attractive to the manufacturer only when the "art" is built into the machine, and operation is reduced to comparatively simple steps. There are limits to this, and here begins the manufacturer's responsibility of furnishing his customer with complete technical information on materials selection, choice of forming technique, mold construction, tooling for production, and finishing methods. There should be basic instruction on pre-printing of sheet plastic and controlled register of art work. If the machine is to be used for packaging, specialized information in this field must be transmitted to the machine user.

The economic success of vacuum forming depends primarily upon modern, multiple-purpose machine equipment; secondarily, upon know-how. Formers who are depending upon obsolete equipment bolstered by know-how, no matter how exceptional, are finding themselves out of the competition. We are entering a critical stage in the evaluation of vacuum forming machine efficiency. Many of the machines now in use are destined for the scrap heap; not so much because they are worn out, but simply because the newer models do more work faster and almost automatically.

—THE END

News of the Societies

SPE New York Section

Nearly 150 members and guests attended the September 18 meeting of SPE's New York section, held at the Governor Clinton Hotel in New York City. Monte Levin, New York industrial designer, served as moderator of the program whose theme was "Published Technical Data—Is It Worth The Paper It's Printed On?" A vacuum forming sub-group meeting was held concurrently in an adjoining room.

James P. Fogerty, polymer chemicals division, W. R. Grace & Co., spoke on "The Use of Physical Test Data For Design Purposes," reviewing the commonly-published test data available in trade journals and company literature. He defined the properties of raw materials as falling into three groups including: those inherent in the material; those effected by the processor; and properties for which no suitable test methods are available. Touching briefly on the first two groups he outlined the inherent and variable characteristics of raw materials, and went on to suggest that such data be considered as a relative, rather than absolute, point of departure. In the third category, Mr. Fogerty stressed the necessity for developing tests which would determine the efficiency of a material in end-use applications. He stated that the development of these tests should be everyone's responsibility, and pointed out that some of the best test methods have come from fabricators, rather than raw material producers.

E. E. Merrill, Dow Chemical Co., discussed "Testing of Polystyrene, Polyethylene, and Cellulosics," maintaining that literature presented by raw material suppliers is a valuable aid to fabricators. Many bulletins describe proper fabrication, coloring, machining, and finishing techniques and contain test data that is a definite necessity in advising customers of the best material for a given application.

W. Ward, American Cyanamid Co., spoke on "Testing of Urea, Melamine, and Phenolics," and stated that a data sheet is valuable if it describes a material without conveying any misaprehension. He pointed out that as industry progresses, literature should become more informative and test data should be tabulated in maximum and minimum values. While most test data are obtained from carefully prepared specifications, values which are useful in one type of fabrication are not necessarily valid for another. The fabricator should not expect too much from his data sheet, and should be ready to substitute his own craftsmanship and experience at that point beyond which the published information cannot go.

C. K. Shaw, Jr., Shaw-Randall Co., Inc., addressed the vacuum forming sub-group meeting on "Machines for Vacuum Forming." He discussed packaging in general, with emphasis on blister packaging techniques. Mr. Shaw indicated that the equipment trends for this type operation are directed toward small-plate machines operating at higher speeds. Trapped-air forming was discussed, and economical heat-sealing methods were described.

SPE Toledo Section

Ernest Csaszar of Newark Die Co., addressed the September 18 meeting of SPE's Toledo Section. Approximately 30 members attended this dinner meeting which was held at the Plantation Inn near Toledo, O.

The steps in building a mold were outlined by Mr. Csaszar, who listed them as follows: quoting, design, approval of drawings, scheduling, responsibilities, and approval of the finished mold. He felt that the three most important factors necessary for an accurate mold were quotation forms, moldmaker knowledge, and responsibility. Quotation forms should be filled out by the molder, and should list such items as knock-out pins, gates, trademarks, parting lines, cooling lines, press fit, molding compounds, number of cavities, and anticipated delivery date.

A moldmaker should have a thorough knowledge of molding techniques and material properties, according to Mr. Csaszar. He suggests that they attend meetings, be on mailing lists for up-to-date literature on plastics, read the technical publications, cooperate closely with customers, and attend available educational courses.

A chart illustrating moldmaker and molder responsibilities was presented. Moldmaker's techniques were balanced against molding techniques; mechanical function with part design, mold performance with knowledge of material properties, and moldmaker's workmanship with the press being used.

Refrigeration Engineers Meet

The tenth annual Air Conditioning & Refrigeration Exposition will be held at the International Ampitheatre in Chicago, Ill., on November 18-21. Over 250 exhibitors will display more than 7,500 pieces of equipment and components, including plastic insulation and vacuum-formed parts. Some papers will be given by members of the American Society of Refrigeration Engineers.

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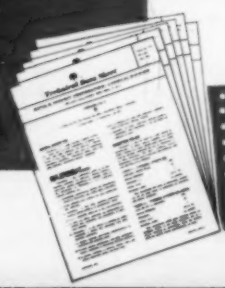

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News of the Industry

Natco Forms New Division

The formation of a plastics machinery division, which will manufacture plastics injection molding machines, has been announced by National Automatic Tool Co., Inc. The firm is a well-known producer of multiple-spindle drilling and tapping machines and automation transfer machines.

Both injection molding machines and Natco metal-cutting machine tools are hydraulically-operated, and production of the two lines can be coordinated with existing facilities. The firm recently completed a new addition to its plant in Richmond, Ind., and a large part of same will be given over to the new division's production. Four standard sizes will be produced, ranging from 16-85 ounces in shot capacity, and in over-all weight from 24,000-85,000 pounds. They should be commercially available this fall.

Natco is the third major machine tool manufacturer to produce injection machines, the others being Reed-Prentice Corp., and Fellows Gear Shaper Co. Heading the new division are Russel W. Powell, sales manager; and Richard M. Norman, chief engineer.

Employs Reinforced Plastics

Owens-Corning's Fiberglas was used extensively in Monsanto's "House of the Future," according to latest reports. Over 23,000 pounds of glass filaments measuring 0.0004-inch were used in the plastic shell alone. Other Fiberglas uses as a plastics reinforcement include the furniture, and the lavatory, tub, walls, and floors of the modular bathrooms.

Upper and lower cabinets, counter tops, and the ultra-sonic dishwasher in the "Atoms for Living" kitchen are molded of reinforced plastic. As thermal insulation, Fiberglas is used in the hollow sections of the walls. Still another use is electrical insulation, and the material is used in much of the wiring.

Announces Expansion Plans

Foster Grant Co., Inc., one of the pioneer molders and fabricators, has announced another expansion within the field of material supply. In November, the firm will open a nylon 6 plant at Manchester, N. H., making use of a special process developed in Germany. This process is reported to be considerably more economical than conventional processes for making polyamides.

The nylon facility will occupy a part of the five-story plant recently purchased from International Shoe Co. The project should cost over $2-million, and its full extent has not been revealed as yet. Estimates on plant capacity are not available; however, adequate provisions have been made for rapid expansions.

Foster Grant entered the material supply business only four years ago, and has made considerable strides since that time. It now has a styrene monomer plant in Baton Rouge, La., the capacity of which is presently being expanded to 105 million pounds. Another plant for producing high-impact styrene is under construction in Leominster, Mass., and should be in operation this fall. A plastics color-blending plant featuring the latest in facilities and equipment has just been completed.

To Provide Added Facilities

A construction program is now underway which will provide increased manufacturing and warehousing facilities at the Koroseal plant of B. F. Goodrich Industrial Products Co., Marietta, O. Completion is expected this fall.

A new building will provide warehousing space to stock coated fabrics, garden hose, and other Koroseal products. Improved shipping service will eliminate the need for maintaining warehouses in other cities. The addition of new production equipment will increase the plant's capacity, and will provide 50 additional jobs.

City Installs PVC Piping

More than 25,000 feet of rigid PVC piping, made from B. F. Goodrich Co.'s Geon resin, has been installed in the municipal park and recreation grounds of San Antonio, Tex. The city made its first PVC pipe installation in the 3½-acre Maverick Park during 1956, and since that time four other parks and two sports centers have been similarly equipped. The local parks and recreation department estimates that projected plans will include some 30-40 parks before the program is completed.

Vinyl film being milled at Ferro's laboratory.

Opens Processing Laboratory

A technical service laboratory, having complete equipment for compounding and testing of all types of vinyl formulations, has been opened by Ferro Chemical Corp., Bedford, O. Mill, press, extruder, and oven facilities are available to simulate actual processing conditions, and tests can be made to determine aging characteristics, ultraviolet light degradation, viscosities, and other properties.

In addition to providing customer service, the laboratory is used as an intermediate proving ground for new stabilizers and chemicals formulated by the research and development department. Other activities include control tests to verify the performance of the company's commercially-available compounding materials.

Doubles Polyethylene Capacity

An expansion program which will double the production capacity of its polyethylene plant at Edmonton, Alta., has been announced by Canadian Industries, Ltd., Montreal, Que. Construction of the new facility will begin this year and, upon completion, will enable the company to make an annual delivery of more than 40-million pounds. Alberta natural gas will be cracked to obtain ethane. This, in turn, will be converted to ethylene, refined, and used as the basis for polyethylene production.

PMS Announces New Addition

The addition of 5,000 square feet of plant space to its home office in Fanwood, N. J., has been announced by Plastic Molders Supply Co., Inc. In addition, the firm has installed a 13-ton, 50-inch, two-roll mill for blending dry colors into polyethylene.

Additional equipment has been acquired for the processing of plastic scrap, and should double the plant's capacity. PMS's

OCTOBER
1957

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

DOW

STRESS CONSIDERATIONS IMPORTANT ENGINEERING ASPECTS OF POLYSTYRENE

RIGIDITY IS NOT ALWAYS BEST INDICATION OF PLASTIC PRODUCT STRENGTH

Great care must be taken when designing a molded plastic part to avoid stress concentrations. The part must be designed so as to distribute energy absorption over as much of the area of the part as possible. Designers often place a reinforcing rib to add stiffness and the result is an area of concentrated stress which causes the part to fail after a short period under load.

Dow Plastics Technical Service Engineers have made a detailed study of the many important engineering aspects of molded polystyrene. Greater over-all strength can often be attained simply by molding a thicker part, rather than by adding ribs which may concentrate stresses.

Thermally induced stresses caused by differential cooling of the part can be reduced by proper design. As a part with an extreme difference in sectional thickness cools after fabrication, the thinner section cools more rapidly. Subsequent cooling and shrinkage of the thick section will cause a sufficient amount of bending in the already hardened thin section to introduce tensile stresses which cause crazing under small loads.

Orientation stresses caused by forced molecular alignment can be controlled to some extent by the design engineer. By considering the fabrication of the part he can usually place the requirements of maximum strength across the direction of orientation.

Dow Plastics Technical Service Engineers have also investigated various factors affecting the physical properties of polystyrene such as aging, temperature and environmental effects, chemical resistance, dimensional stability and many others. This is but one of a series of continuing Plastiatrics studies covering every phase of plastics formulation, design, molding and finishing. For your copy of the paper entitled, "Engineering Aspects of Polystyrene", write THE DOW CHEMICAL COMPANY, Midland, Mich. Plastics Sales Dept., 1546K.

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- STYRON 480 (Extra-High Impact)

HEAT RESISTANT
- STYRON 683
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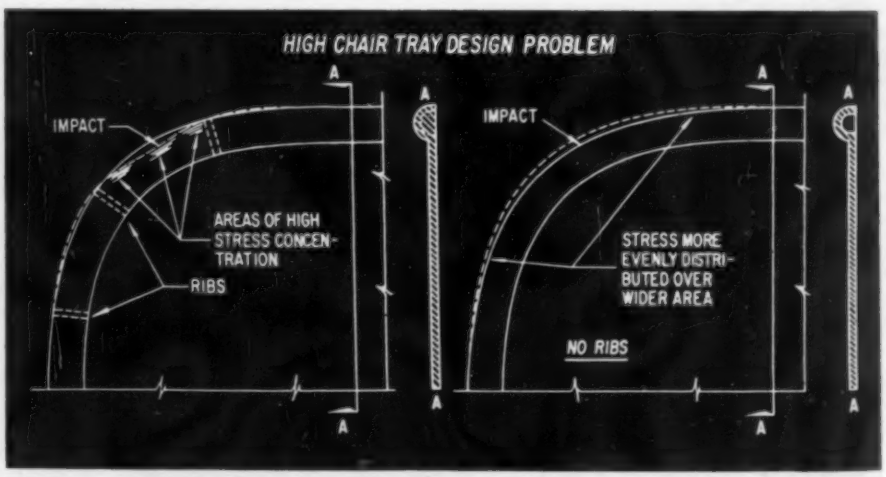


High chair tray shown above, left, is an example of what happened when the design was too rigid. Ribs were used extensively as shown. When the tray was dropped on its edge, the force of impact was concentrated between two ribs and the rim broke. When tray was molded without ribs, above, right, the force of impact was spread, the deflection less, and the rim did not break.

YOU CAN DEPEND ON DOW

expansion program began a year ago with the opening of a branch plant in Sandusky, O., and has continued with the establishment of branch offices throughout the country. The firm is now one of the nation's major suppliers of dry colorants and paste dispersions for thermoplastics.

Schedules Service Laboratory

A technical service laboratory, to be completed in early 1959, is being built by Union Carbide Chemicals Co., near Tarrytown, N. Y. The building will be situated on a 280-acre site, and will house 63 individual laboratory units.

The proposed three-story structure, measuring 360 by 60 feet, was designed by the architects Skidmore, Owings, and Merrill. Complete analytical facilities to service a total of 24 major industrial fields will be available, and a 200-seat auditorium will be used for seminars and other technical meetings.

Expands Laboratory Facilities

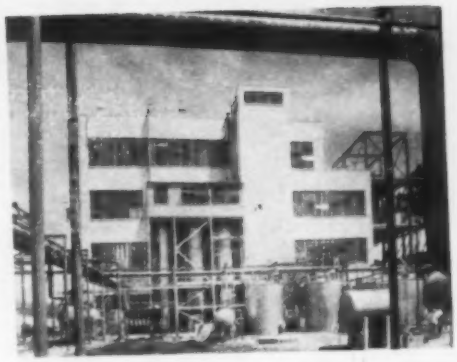
A $700,000 expansion of its sales service laboratories at Chestnut Run, Del., has been announced by E. I. du Pont de Nemours & Co. Plans involve addition of a new wing to the existing structure which was first opened to the plastics industry three years ago.

The 11,000 square-foot building will be attached to the present administrative wing and will house 56 separate offices. Construction will be completed by mid-1958. A company spokesman indicated that the expansion is needed to carry on development work with new products. Scheduled operations include technical assistance to customers, design and testing of new applications, and development of new processing techniques.

Hercules Polyethylene Plant

Hercules Powder Co.'s multi-million dollar Hi-Fax plant is now on stream in Parlin, N. J. First in the United States to employ the Ziegler process for the manufacture of high-density polyethylene, the new facility has an estimated capacity of 30-million pounds annually. Prior to opening the plant, Hercules had sold over a million pounds of Hi-Fax obtained through a two-way exchange agreement with Farbwerke Hoechst, A. G., of West Germany. This firm was the first to adapt the Ziegler process to commercial production.

The Parlin plant obtains ethylene by pipeline from Esso Standard's refinery at Linden, N. J. The catalyst system is added



Hercules' Hi-Fax plant at Parlin, N. J.

to the diluent in the polymerizer, and a polymer is formed from the ethylene gas. This polymer, slurried in the diluent, is treated to decompose the catalyst. Following filtration, purification, and drying, the polyethylene is pelletized to produce Hi-Fax molding powder. Natural and colored materials are available.

All polymerization and compounding equipment was designed specifically for this plant, and features a high degree of instrumentation. Electric lines are insulated with Hi-Fax, and the material is used extensively in the control system. Other facilities at Parlin include a plastics laboratory staffed by specialists in the field.

Purchases Plastics Company

The Seamless Rubber Co., New Haven, Conn., has purchased the plastics pipe-fittings firm of E. & A. Sales, Inc., Los Angeles, Calif. The acquisition includes all sales facilities, tools, molds, dies, and designs.

Seamless Rubber plans to streamline and modernize the West Coast company's operations which currently include the manufacture of approximately 170 different plastic pipe fittings in Kralastic, Tenite II, and rigid PVC. Production will be increased by the addition of two new basic machine units.

Companies Complete Merger

According to a joint announcement made recently, Dayton Rubber Co., Dayton, O., and Cadillac Plastic and Chemical Co., Detroit, Mich., have completed a merger through an exchange of stock.

Under the terms of the agreement, there will be no change in Cadillac Plastic's operating policies. It will retain its corporate name, continue under its present management, and function as a wholly independent subsidiary of the Dayton Rubber Co.

Purchases West Coast Firm

The plant and equipment of Graef Engineering Co., have been purchased by Raybestos-Manhattan, Inc., and will be operated as a divisional manufacturer of the parent firm's Teflon, Kel-F, Raylon, and nylon products. Arthur W. Byxbee, former sales manager of R-M's plastic products division, has been appointed general manager of the new division; and former owner O. K. Graef has been appointed plant manager.

Among the division's functions will be the manufacture of extruded and molded rods, tubes, and centerless ground rods; spray coating of metal parts; and the stocking of Teflon sheet, tape, etched tape, expansion joints, and couplings.

Changes Corporate Designation

Greer Industries, Inc., manufacturer of a new urethane material called Disogren, has changed its corporate name to Disogren Industries, Inc. The firm's affiliation with Greer Hydraulics, Inc., terminates simultaneously.

Chief operating officer is Robert E. Williams, former operational manager of Greer Industries. Company headquarters will remain at New York International Airport for the time being; however, a move to a new and expanded plant is contemplated for the near future.

Plans Second Petrothene Plant

A second plant for the production of polyethylene resins will be built by National Petrochemicals Corp., a firm majority-owned by the U. S. Industrial Chemicals Co., division of National Distillers & Chemical Corp.; minority-owned by Panhandle Eastern Pipeline Co.

A 200-acre site on the Houston Ship Canal, near Houston, Tex., has been selected for the facility. This area has been set aside for industrial development by Phillips Petroleum Co., who will supply high-purity ethylene from its plant in Sweeny, Tex. Phillips also will supply the natural gas requirements of the plant.

Scheduled to commence operations by late 1958, the facility will produce 75 million pounds per year of intermediate-density polyethylenes. The material being produced at the older Tuscola plant has a density of 0.91-0.94, and the new unit will offer resins at the 0.94 figure. Polyethylenes produced by the Ziegler process average 0.96 in density.

The newer materials will be produced by a high-pressure technique similar to that employed in the manufacture of conventional polyethylenes. They will be sold under the established trademark Petrothene. The firm also is erecting a polyethylene compounding plant at the Tuscola site. This facility should be producing 25 million pounds of colored and filled polyethylenes by mid-1958.

Air Reduction's research laboratories, with polymer facility sketched in.

Expands Research Facilities

A two-story laboratory for the development of polymers used in paints, adhesive, plastics, and coatings, is under construction at Air Reduction Co's facilities, Murray Hill, N. J. Completion of the half-million-dollar project is scheduled for the end of 1957.

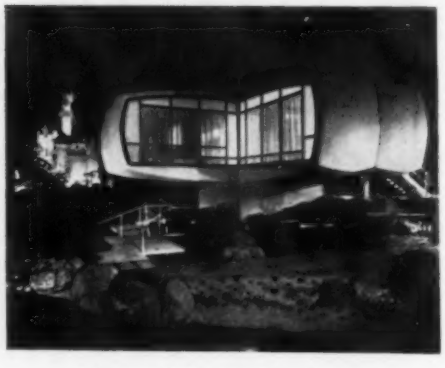
Construction of the polymer laboratory will add a new wing to the building which houses the company's chemical, metallurgical, and cryogenic research facilities. About 35 persons will be added to the present staff in order to maintain operations.

Opens House of the Future

An all-plastics "House of the Future," the product of more than three years research by Monsanto Chemical Co., Massachusetts Institute of Technology, and 12 cooperating home equipment and building supply firms, was opened to the public recently at Disneyland Park, Anaheim, Calif.

Basis of the design is a curved, hollow plastics module measuring eight by 16 feet. This is used to form ceiling, walls, and floor. In the first demonstration and test house, 16 of these sections are cantilevered from a 16 square-foot utility core to form four separate wings.

The many-curved modular sections were made of Fiberglas-reinforced plastic by Owens-Corning Fiberglas Corp. Plastic-based interior and exterior paints were supplied by National Lead Co.; vinyl floor coverings by Armstrong Cork Co.; fabrics by Chemstrand Corp.; and the foamed urethanes used for insulation, furniture cushioning, and rugs, were furnished by Mobay Chemical Co. Plastic House at Disneyland.



Monsanto's house of the future.

Artist's concept of Modiglass plant.

Erects Glass Fiber Plant

A new production facility is under construction for Modiglass Fibers, Inc., on a 26.5 acre site at Bremen, O. The building will enclose more than 40,000 square feet of floor space.

Ventilation will pass through filtered louvres to prevent contamination of the glass fiber product. The building has a structural steel framework with a poured gypsum roof, while the exterior walls are of light-weight concrete block with vision areas of reinforced plastic glazing.

The company, formerly known as Modigliani Glass Fibers, Inc., manufactures glass fiber surfacing mats, veils, structural mats, and decorative materials for the reinforced plastics field.

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In Brief . . .

Penn Plastics Corp., has installed the first unit of a planned series of fully-automatic compression molding facilities. They will be housed in the firm's new plant at Glenside, Pa.

Heyden Newport Chemical Corp., is building a methyl isopropyl catechol plant in Pensacola, Fla. The turpentine-based chemical acts as a stabilizer for synthetic rubber, an anti-oxidant, and a polymerization inhibitor for polyester resins.

National Electronic Plastics, Inc., has appointed the following sales agents: William Cohen, Montreal, Que.; Don V. Hamilton, Minneapolis, Minn.; Fred H. Haight Co., Seattle, Wash.; and Morhan Exporting Corp., New York, N. Y.

Koppers Co.'s chemical division has opened sales offices in Kansas City, Mo., and St. Paul, Minn. John Sharp and Robert C. Clarke, respectively, have been appointed sales representative in charge of the new offices.

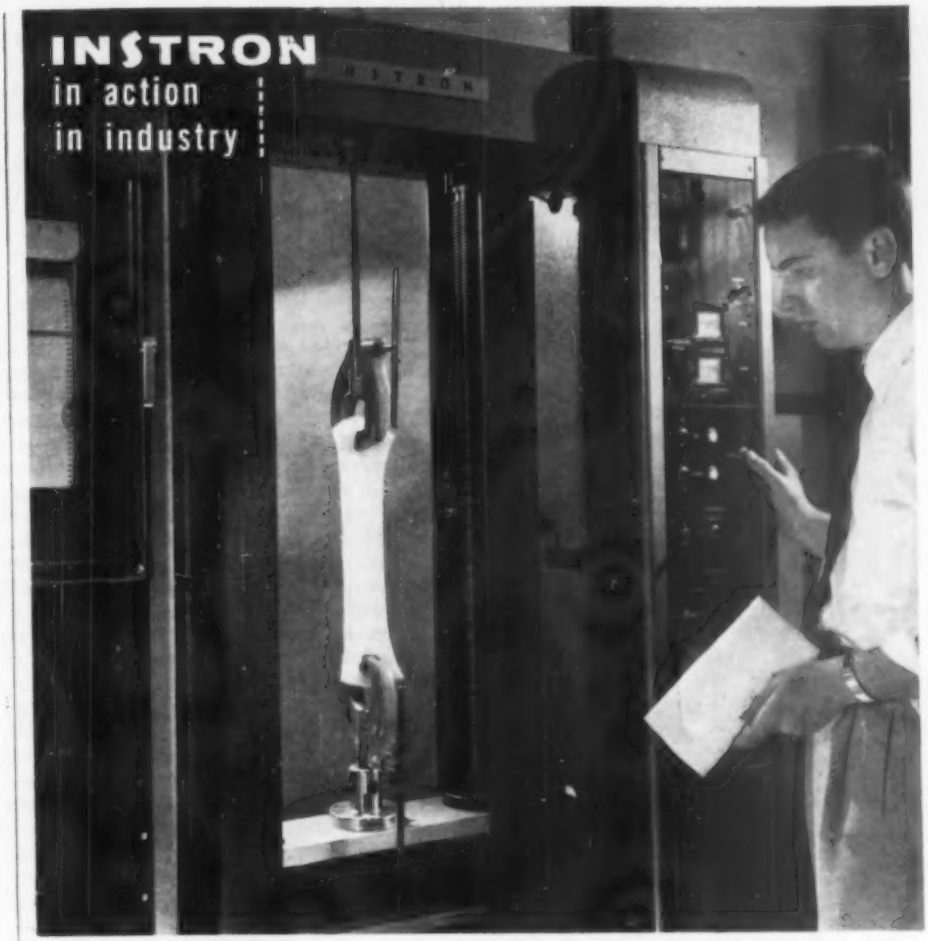
Synthane Corp., has moved its Detroit sales office to 920 East Lincoln, Birmingham Mich.

E. V. Roberts & Associates, Pacific Coast distributor for Shell Chemical Corp.'s epoxy resins, has moved its northern California offices from Redwood City to 1560 Laurel St., San Carlos, Calif.

Tracerlab, Inc., has consolidated its seven operations in Boston into one new building in Waltham, Mass. Manufacturing area, sales offices, engineering and research facilities, radiochemical facilities, and general administration have been provided for in the 164,000-square foot plant.

E. I. du Pont de Nemours & Co., Inc., has announced price reductions ranging up to 25 cents per pound on most types of Mylar polyester film. All coated and heat-shrinkable types, plus Types A and D in all gages are affected by the price slash.

Isocyanate Products, Inc., has become the sole sales and service representatives for the polyurethane foam machinery manufactured by Newton Tool & Mfg. Co., Inc., Wenonah, N. J. The equipment is designed to meter and mix two-component polyurethane systems.



A Chrysler Corporation technician watches as the Instron stretches a piece of foam rubber seat cushioning material to its limit to determine ultimate elongation and tensile strength.

How Chrysler Corporation uses the Instron Tester

At Chrysler Corporation's Organic Materials Laboratory, Highland Park, Michigan, the versatile Instron is used to measure physical characteristics of rubber and plastic materials with electronically controlled accuracy.

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News from Abroad

British Plastics Exposition

The 1957 British Plastics Exhibition held in London last July drew a record attendance in both exhibitors and visitors. Though international in scope, foreign participation was somewhat less than might have been expected due to a poor response by raw material producers. European machinery manufacturers from France, Germany, and Italy exhibited injection molding equipment, extruders, and a fully-automatic machine for coating textiles, paper, etc., with any thermoplastic composition.

Plastics materials were shown in various applications, among which were melamine laminates and table ware; a full-size bath tub made of an acrylic material; polyurethane, PVC, and polystyrene foamed products; caprolactam nylons produced in Holland (Akulon) and Switzerland (Grilan); German Supronyl films (Perlon); and a castor oil derivative from France (Rilsan). Centrifugal castings and extrusion moldings of Akulon were demonstrated by Algemene Kunstijde Unie, Holland.

Cellulose propionate moldings made from Forticel were shown by British Celanese, while a Swedish firm exhibited a black phenolic molding with an intricate silver inlay. A terrazzo-type flooring, made of multi-colored, high-impact, polystyrene molding pellets embedded in concrete was displayed by Monsanto Chemical Co. A British firm featured a vacuum formed polystyrene sheet for wall covering.

Reinforced plastics appeared in numerous applications including Telcomesh, a polyethylene reinforced with an open-mesh, woven-glass fiber. This material is said to be suitable for conveyor belts, tank linings, roofing, green houses, etc. Other reinforced plastic items included a glass-reinforced polyester green house, aircraft components, and trailer and ambulance bodies.

Plastics in Finland

Although established in 1921, the Finnish plastics industry did not show signs of growth until the end of World War II. Today, there are over 150 manufacturers, employing an estimated 3,000 people to produce household articles, plastic foils and films, floor coverings, electrical parts, and toys. During 1955, an estimated $14.1-million worth of plastics items were produced. The industry enjoys no foreign investment, and no foreign branch or affiliated companies have been established.

Continued expansion of the country's plastics industry has been impeded by the shortage of all types of modern machinery. The Finnish Plastics Association, representing about 95% of the industy, has made strenuous efforts to obtain a greater allocation of foreign currency for the purchase of new equipment. Domestic production of plastics machinery is limited to a number of small presses, although the greatest demand is for injection molding machines and extruders.

The industry is largely dependent on imported plastics raw materials, most of which come from Great Britain, West Germany, Norway, and France. Although U. S. plastics materials are highly regarded, prevailing foreign exchange restrictions preclude any large amounts of such imports. During 1955, American products were permitted on about 5.8% of the total licenses issued. These were valued, in the aggregate, at $4.9 million.

British Petrochemical Plant

Plans to erect a petrochemicals plant at Fawley, England, for the manufacture of ethylene oxide derivatives, have been announced by Union Carbide Corp., New York, N. Y. To be operated by the company's British affiliate, Union Carbide, Ltd., the new plant is scheduled to commence operations in 1959 and will have an annual production capacity of 45-million pounds.

The Fawley plant, which will employ 150 people, is the second major petrochemical facility being constructed by Union Carbide in the United Kingdom. The first, a 24-million pounds per year polyethylene unit at Grangemouth, Scotland, is scheduled for completion this month.

British Plastics Trade

Exports of plastics materials from Great Britain during the first half of 1957 reached a record total of 55,626 tons. This represents an increase of 8,433 tons over the same period in 1956. Nearly 10% of the total produce was absorbed by the Australian industry, followed by France and India as the second and third largest consumers.

Nearly all types of materials shared in the increase with the exception of ureas, phenolic molding powders, and acrylic sheet. Acrylic molding powders remained unchanged. Imports of materials for the period under consideration came to 15,001 tons, as compared with 11,450 tons during the first half of 1956.

German Research Institute

Culminating nearly 20 years of effort by representatives of German industrial and scientific circles, the Plastics Research Institute was opened at a formal ceremony held recently in the city of Darmstadt. First envisaged in 1937, but shelved during the subsequent war-mobilization, the project remained dormant until 1949.

Interest in the program led to the formation of the Plastics Research Association with headquarters at Frankfurt-am-Main. In 1953, concrete proposals were made to erect suitable laboratory facilities on the grounds of the Darmstadt Technological Academy. Construction of the three-story building and annex begun in 1955, was completed this year at a total cost of nearly 4-million DM. Of this money, 60% was contributed by members of the Association, while 40% came from government subsidies.

Directed by Professor K. H. Hellwege, the permanent staff will consist of 37 members including the heads of the department of physics, chemistry, physical-chemistry, and documentation. Experimental work has begun on the infra-red spectra of polethylene, orientation of plastics during mechanical deformation, diffusion of plasticizers in PVC, thermal conductivity of plastics, and the effects of high energy radiation.

German Radiation Facility

An electron radiation facility was established recently in Cologne, Germany, by Leybold-Hochvakuum Anlagen, G.m.b.H., and High Voltage Engineering Corp., of Burlington, Mass. Incorporating a two-million volt, 0.5 kilowatt Van de Graaff electron accelerator, the center is the first in Western Europe to be made available on a commercial basis.

The radiation source was supplied by High Voltage, and the facility will be managed and operated by Leybold, the American firm's representative in Western Germany, Switzerland, and Spain. The move represents another step in High Voltage's expanded service abroad. The company now has nine foreign sales and service organizations spread across both hemispheres.

Instantaneous Polymerization

A new polymerization technique has been developed in France, which portends a complete change in the processing of laminates. The method apparently involves the judicious combination of physical treatment and catalysts to promote the formation of molecular linkages. For some months, an experimental machine has been producing tubing continuously and rapidly

with a polymerization time of 0.15-second.

Rigid and flexible laminates, natural or colored, can be produced at these rates regardless of the thickness or nature of the fabric used. Linear dimensions are reportedly not a factor. Polymerization can be limited to a treated surface, or can be obtained throughout the laminate. It is predicted that production rates 200-500 times higher than those now in effect can be obtained with the process. Among the applications suggested for the technique are the automatic production of plain and corrugated sheet, profiles, and tubing; plus the semi-automatic production of parts molded in series.

Plastics in Guatemala

Guatemala does not produce plastic materials, its main source of supply being the United States. Until late 1954 only one company produced plastic articles, but 1956 found 10 companies producing a variety of plastics products. All are located in Guatemala City.

Consumption figures for 1956 were estimated at 846,000 pounds, mostly in granular and powdered form for molding and extrusion. Machinery currently on order should increase this figure to about 1.5-million pounds.

Public acceptance of plastics materials is good, and several firms are adding plastic pipe, coated wire, dishes, squeeze bottles, and foamed products to their regular lines. The processing industry uses food containers, soap boxes, combs, toys, buttons, tableware, novelties, belting, and garden hose. Rigid plastic sheeting is used in making table tops, and flexible sheets are used in the manufacture of wallets, pocketbooks, and the like.

Although the United States enjoys a favored position; Canada, Germany, and Italy are beginning to compete for the market. There are no exchange restrictions which limit the availability of dollars for the purchase of plastic materials. Invested capital in molds and machinery is entirely of domestic origin, and no foreign manufacturers have branch factories in Guatemala. No special marketing agreements exist.

The country has an industrial development law under which certain types of industries are granted privileges such as exemption from payment of taxes, duties, fees, and surcharges. The plastics industry is granted this exemption on raw materials, machinery, and accessories only once; however, the exemption may be extended by supplementary requests.

Plastics in Indonesia

There is no production of plastics materials in Indonesia; however, the manufacture of plastic items from imported materials is reportedly a growing industry. The country's petroleum output should offer excellent opportunitities for the eventual manufacture of resins, but this section of the industrialization program has a very low priority.

It is estimated that 35 firms are consuming about 2,400,000 pounds of polystyrene annually; and 10 other firms are using 50,000 pounds of polyethlene, 200,000 pounds of phenolics, and 40,000 pounds of urea resins. Plastic materials are imported in the form of powder or pellets, except casein, which is obtained in rough shapes for final machining; PVC in liquid, film, and sheet form; and nylon in reels, filaments, or bristles.

The processing industry is limited to injection and compression molding. There are no extrusion, laminating, or coating operations. Several firms interested in the extrusion of sheet and coating operations have been unable to obtain import licenses for the necessary equipment.

Distribution of Indonesian-made plastic products is through the usual wholesaler-retailer channels, although the former is bypassed in some instances. There is a great deal of reselling among middlemen, especially for the provincial trade, which tends to increase the already-high prices for plastic products.

There are only two foreign (Netherlands) firms in Indonesia, and they account for about 3% of the total production. Know-how among processors is said to be the greatest deterrent to the development of an Indonesian plastics industry. The United States ranks fourth after the United Kingdom, Canada, and Germany as a supplier of plastics materials. Their relative position has been maintained for 3-4 years, and shows no sign of changing markedly.

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Names in the News

Stephen B. Sponder

Stephen B. Sponder has been appointed plant manager for Baker Brothers, Inc., Toledo, O., builders of plastic molding presses and machine tools. Mr. Sponder previously served with Brower Mfg. Co., Ohio Tool Co., U. S. Defense Corp., and with Baker Brothers as personnel manager.

Thiokol Chemical Corp., Trenton, N. J., has announced the appointment of two new technical sales representatives. They are: **Ernest Ray Sutton, Jr.,** whose radius of operations is centered at Chicago, Ill.; and **Henry James O'Neil,** who will cover Ohio, Michigan, and Indiana, from headquarters at Detroit, Mich.

Thomas O. Williams has been appointed assistant sales manager of the film division, American Viscose Corp., Philadelphia, Pa. He previously managed the division's customer and sales service department.

Ernest O. Lawrence, professor of physics and director of the University of California's radiation laboratory, has been elected a member of the board of directors of Monsanto Chemical Co., St. Louis, Mo.

Tracerlab, Inc., Waltham, Mass., has announced the appointment of **John Eills** as manager of the firm's newly-opened sales office in St. Louis, Mo. The office will expedite customer service to Iowa, Missouri, Nebraska, Kansas, and parts of Illinois, Indiana, Kentucky, and Tennessee.

Thomas Holdridge has been named to head the newly-created technical sales service department of Narmco Resins & Coatings Co., Costa Mesa, Cal. The department was formed to augment the firm's technical assistance to customers utilizing adhesives and laminating materials in aircraft and missile design.

Newton R. Crum has been named western regional sales manager for Chemtrol Corp., Compton, Cal. His new responsibility includes sales and distribution of the company's line of plastic valves and piping systems in 11 western states.

Robert F. Traflet has been appointed technical representative for the molding materials division, Bakelite Co., New York, N. Y. From headquarters in Detroit, Mich., he provides customer and sales service for all Bakelite molding materials in the eastern and southeastern parts of the state.

Arthur J. Warner of Harlow, Essex, England, has been named director of research for Mycalex Corporation of America, Clifton, N. J. His responsibilities include material and product development in electronic components as well as glass bonded mica, ceramoplastic insulation, and synthetic mica for both the parent and associated companies.

Charles B. Morgan has been named general manager of production for Synthane Corp., Oaks, Pa. He succeeds **Duane E. Roland,** who has retired after 28 years of service.

John A. Vormbaum, comptroller and secretary of Lunn Laminates, Inc., Huntington Station, N. Y., has been appointed treasurer of that corporation.

T. R. Callahan has been appointed midwestern sales representative for the Watson-Stillman Press Division, Farrel-Birmingham Co., Roselle, N. J. His headquarters are at the company's office in Chicago, Ill.

H. D. Allick has been named sales development manager for the chemical division's plastics department at Goodyear Tire and Rubber Co., Akron, O. Other appointments within the department include: **D. W. Klune,** promoted from trainee to sales service staffman for vinyl products; and **A. A. Ash,** who has been assigned to the sales training program.

William J. McCaig

William J. McCaig has been appointed manager of Polyfoam sales for General Tire & Rubber Co. Mr. McCaig has held several sales-executive posts, most recently with Federal Enameling & Stamping Co.

W. Ben Evans has been named eastern district manager for the plastics machinery division, National Automatic Tool Co., Inc., Richmond, Ind. Headquartered at Windsor, Conn., he uses the company's offices at Mt. Vernon, N. Y., and Wellesley Hills, Mass., to provide sales service to customers in New England, eastern New York, and northern New Jersey.

National Polychemicals, Inc., Wilmington, Mass., has announced the appointment of **Joseph P. Flannery** as sales manager. **Jean H. Nesbitt** was named midwestern district manager with headquarters at Buffalo, N. Y. and **Hugh W. Gillon** becomes a midwestern sales representative. **Charles B. Riley, Jr.** was appointed to the technical staff as chemist.

Frank E. Eden has been promoted to the staff of the development and service department, Emery Industries, Inc., Cincinnati, O. His responsibilities include market development of new chemical products, as well as technical service for the firm's line of acids, esters, and plasticizers.

George W. Hoffmeister has been named general superintendent of Minneapolis-Honeywell Regulator Co.'s new plant at Fall River, Mass. He formerly was superintendent of assembly operations at the company's plant in Philadelphia, Pa.

P. T. Francis has been appointed sales manager of Quelcor Products, Inc., Chester, Pa. In addition to heading the company's PVC products sales, he will direct the establishment of commercial applicators and the installation of Quelcor in-plant systems.

Richard A. Paisley has been named sales and application engineering representative for the custom molding division, Chicago Molded Products Corp., Chicago, Ill. From headquarters in Cleveland, O., he handles sales operations in that State.

J. G. Carden, sales representative for Owens-Corning Fiberglas Corp., has been transferred to the firm's New York office from Washington, D. C.

Harold T. Sumner has been appointed plant manager for Northwest Plastics of Carolina, Inc., Gastonia, N. C. **Donald A. Bullard,** who as plant manager will supervise technical details at the new factory, has been transferred from the parent company, Northwest Plastics, Inc., St. Paul, Minn.

Monsanto Chemical Co., St. Louis, Mo., has announced the assignment of new personnel to various departments within its plastics division. Appointees include: **David E. Schoeffel, Harry R. Littleton,** and **Charles R. Ellicott III;** to research, Lustrex, and advertising, respectively, at Springfield, Mass. Joining the divisional facilities at Texas City, Tex., **Donald G. Mayo** has been assigned to production, and **John E. Hays** to engineering.

James R. Davidson

James R. Davidson has been named vice president and general manager of Capac Industries, Inc., Capac, Mich. His appointment marks the firm's expansion into the fields of extrusion, forming, and general molding. Mr. Davidson served most recently as executive secretary of the Society of Plastics Engineers, Inc. Prior to that, he served as sales manager of Hoosier Cardinal Corp.'s plastics division.

Donald Roon, former executive vice president of Houghton Laboratories, Inc., Olean, N. Y., has been elected president of that organization. He succeeds **Russell M. Houghton,** who has resigned.

Peter N. Triano has joined Interplastics Corp., New York City, as sales representative. The firm supplies a complete line of thermoplastic molding materials for domestic and foreign consumption, and purchases surplus inventories and plastic scrap.

Joseph W. Mackenzie was elected secretary, and **George R. Beck** assistant treasurer, at a recent meeting of the board of directors, Plumb Chemical Corp., Philadelphia, Pa.

photos by National Automatic Tool Company, Inc., Richmond, Ind.

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Non-Bleed Azo Red Pigment

A BON red pigment with improved light resistance over the conventional, non-bleeding, azo red pigments has been introduced by the pigment, color & chemical division of Sherwin-Williams Co. Bluish red in shade, Polaris Red CP-1285 is particularly adapted to use with vinyls, polyethylenes, and synthetic fibers. It has tinting strength similar to the Lithol Rubines.

Chemically, the pigment is a metallic salt of a diazotized aryl amine-sulfonic acid coupled to beta-oxy-naphthoic acid. In masstone, CP 1285 is lighter and brighter than Rubanox Red CP 762 and Solfast Red CP 1257; in print tone, it is considerably bluer than CP 762 and CP 1257. Properties include a specific gravity of 1.56; a bulking value of 0.07698; and a weight per gallon of 12.99 pounds.

Readers' Service Item M-1

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Three Vinyl Stabilizers

Three stabilizers for vinyl resins have been introduced by the chemical division of Metal & Thermit Corp. They are: Thermolite 25, a complex organotin compound; Thermolite 112, a barium-cadmium liquid; and Thermolite 166, an organic zinc material.

Thermolite 25 is a slightly-viscous light yellow liquid which is said to impart excellent heat and light stability to PVC compounds. Sulfur-free, it does not have the characteristic mercapto odor associated with many stabilizers. It will not cross-stain when placed in contact with a vinyl sheet which has been stabilized with lead or cadmium stabilizers. Decomposition temperature is above 200° C., flash and fire points are above 175° C., and the freeze point is below 0° C. Tin content averages 16.5-17.5%, and the Gardner color point is 4.

For rigid compounding of straight PVC or copolymer resins, suggested ratio is 2-4 parts Thermolite 25 per hundred parts resin. Sufficient lubricant should be added to give the desired processing characteristics. Other applications include clear, flexible hose, plastisols, organosols, and clear overshoes.

Thermolite 112 is a single-package stabilizer, completely free of any fatty acids which would affect the heat sealability and printability of vinyl film. Plate out on calender rolls is at a minimum, and there is no yellowing at high temperatures. An amber-colored liquid with a specific gravity of 1.05, the material has a flash point of 100° C., and a pour point below —20° C. Thermolite 112 is excellent for clear film and sheeting, all extrusion operations, plastisols, and organosols.

Thermolite 166 is a light yellow liquid with a specific gravity of 1.02. Its flash point is 257° F., and the Gardner color is 9 maximum. Recommended for use with Thermolite 112 or other barium-cadmium stabilizers, it affords better heat stability at lower cost. Particularly useful in preventing plate out, it has a viscosity of 238-333 cstks., and a pour point of —36° C.

Readers' Service Item M-2

Epoxy Resin Curing Agent

A compound long used in the medicinal field, 4,4'-diaminodiphenylsulfone, has been found an effective curing agent for liquid epoxy resins by Merck & Co., Inc. It produces a cured resin with ASTM heat distortion points in the range of 175-195° C., depending upon the formulation and cure cycle. Substantially less reactive than m-phenylenediamine or methylenedianiline, it can be used with an accelerator such as boron fluoride ethylamine complex to shorten the cure cycle.

In a typical casting procedure, 30-36 parts DDS are stirred into 100 parts epoxy resin, which has been preheated to 270° F. When a homogeneous mixture has been obtained, the mass is cooled to 250° F., and poured. About 0.5-1 parts per hundred of the accelerator can be added after the mixture has cooled to 200-210° F. A representative cure scheduled for an accelerated casting is five hours at 260° F., followed by a post cure of one hour at 390° F.

Acetone or methyl ethyl ketone is a good laminating solvent in glass-cloth laminations. About 30 parts of DDS can be dissolved in an equal weight of hot acetone with agitation, followed by one part of the accelerator. After solution is obtained, 100 parts of a liquid epoxy are blended into the mixture. Glass cloth (181 Volan A) laminates have been obtained from this formulation with ultimate flexural strengths ranging from 100,000 psi. at room temperature to 13,000 psi. at 500° F.

From the toxicological standpoint, Merck DDS has not resulted in a single case of skin irritation or "browning." This is in sharp contrast to the severe dermatitis and discoloration frequently encountered with amine hardeners.

Readers' Service Item M-3

Preform Screen Lubricant

A release agent for glass fiber-polyester preforms from the perforated metal screens used in performing has been introduced by Ram Chemicals. Called Preform Screen Release 226, the material is a heat-reactive coating which adheres to the perforated metal and deposits a nearly invisible film. Normal preform binders and powders will not wet and stick to the coated surface.

The product can be sprayed, brushed, or wiped onto the screens which should first be sand blasted or solvent cleaned. One or two coats are applied, allowing a 20-minute drying period in between coats. Cure is effected at 250-300° F., for another 20 minutes. The screens can be returned to processing immediately after using. The release agent is supplied in one-, five-, and 55-gallon containers.

Readers' Service Item M-4

Silicone Mold Release Spray

An aerosol-backed silicone spray for use as a mold lubricant has been announced by Schuco Industries. Called Schuco Mold-Release Spray, the product is based on a GE silicone compound which is particularly effective as a mold release agent for plastics. In this capacity, it reduces molding cycle time and rejects, at the same time improving product finish. The spray can holds 12 ounces.

Readers' Service Item M-5

RESIN RELEASE N

Expensive, complicated plastic parts are released from molds easily, quickly and safely each and every time with this new Non-Silicone, Non-Melting parting agent, Resin Release N. Works perfectly up to 450°F., without viscosity change or deterioration. It's water-repellent and non-toxic. Resin Release N easily removed for painting or secondary bonding.

Successfully used in tooling, plastic laminating, molding, potting, casting and bonding operations involving epoxy, polyester, phenolic, silicone, neoprene, melamine, urea, alkyd and vinyl plastisols. Approved and accepted by leading aircraft, missile, electronic and component manufacturers.

SPECIALTY PRODUCTS Company

Mold Release Specialists for over twenty-five years

SPECIALTY PRODUCTS COMPANY
Release Agents Div.
194 Warren Street, Jersey City 2, N. J.

Please send Free Sample of Resin Release N to:

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Company_____

Address_____

City_____ Zone____ State_____

New Equipment

Write item numbers on Readers' Service Card to obtain more information.

Model A Dispenser for epoxies and hardeners.

Epoxy & Hardener Dispensers

An automatic dispenser for delivering metered quantities of epoxy resins and hardeners has been introduced by Kish Industries, Inc. Called the Ki-Pla-Blender, the machine is offered in two models differing only in size and accessories. Both will deliver as little as 10 grams, or more than three pounds.

Action is simple. The operator merely turns a crank, and the material is dispensed through separate, side-by-side nozzles. Accurate metering is achieved by non-slip gears engineered to activate positive-displacement pumps, which require very little maintenance or cleaning. Not only will they deliver epoxy laminating resins, casting resins, and hardeners; but they can be adapted, on request, for polyester resins.

Unit A weighs approximately 89 pounds, and comes with heavy duty motor, reducer, stand, two five-gallon containers, and accessories. This larger model is available for operation entirely by crank at a reduced price. Unit B is a smaller unit operable only by crank. It weighs 43 pounds.

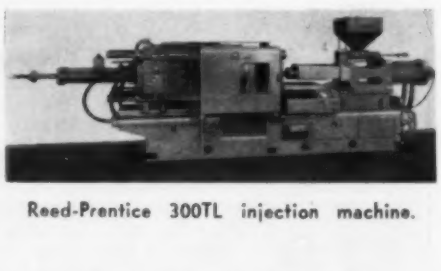
Readers' Service Item E-1

Injection Molding Machine

An injection molding machine for deep-draw products in the 12-16 ounce range has been developed by Reed-Prentice Corp. Known as the 300TL, the unit's built-in stuffing arrangement operates through multiple injection strokes. An optional low-pressure die-closing arrangement prevents damage to the mold should a molded piece fail to eject during an automatic cycle.

The double-shear toggle mechanism provides positive, mechanical mold-locking pressure, and the die-space adjustments are by hydraulic rather than mechanical means. Machine controls are grouped in a central panel, below which the water-cooling sight manifold is clearly visible. Three proportioning pyrometers and automatic cycle timers are mounted in a separate steel cabinet. Safety is assured through hydraulic and electrical interlocks.

Material injected per shot, oz.	12-16
Cubic inches	16
Plasticizing capacity, lbs./hr.	125
Hopper capacity, lbs.	150
Injection pressure, psi.	20,000
Total pounds	141,760
Injection plunger diameter, in.	3
Injection cylinder diameter, in.	9.5
Plunger stroke, in.	13
Plunger speed, in./min.	130
Mold clamping pressure, tons	350
Mold opening pressure, tons	9.5
Mold clamping stroke, in.	8.5-20
Mold thickness, max. in.	20
Minimum, in.	8
Mold size, max. in.	29 x 20.5
Platen size, in.	29 x 32.5
Distance between tie bars, in.	15 x 20.5
Tie bar diameter, in.	4
Casting area, sq. in.	150
Cycles/hr., max.	300
Motor, hp.	30
Heater, kw.	21.7
Oil reservoir capacity, gal.	150
Machine length, ft.	24
Width, ft.	5
Height, ft.	7
Weight, lbs.	21,000



Reed-Prentice 300TL injection machine.

Readers' Service Item E-2

Model 55 Air-Jet Wasp Mini-Jector.

Miniature Injection Machines

A new line of improved Mini-Jector injection molding machines have been introduced by Newbury Industries, Inc. Designed to produce unlimited varieties of small molded items, the units use standard mold blanks to mold any thermoplastic material. These blanks are available either 4½ or six inches long in different types of steel. Working blueprints are available, so that the molder can make his own tapered, self-locking mold.

The ¾-ounce Model 55 Wasp Mini-Jector can be obtained with any of four different-size cylinders. There is, of course, a corresponding decrease or increase in injection capacity, with the following shot capacities being available: ⅛-, ½-, ¾-, and one ounce. Rams also must be changed.

Specifications for the standard ¾-ounce air-operated unit are as follows:

Plasticizing capacity, lbs./hr.	5.5
Air cylinder diameter, in.	6
Injection ram diameter, in.	0.75
Stroke, in.	6
Mold casting area, max., sq.in.	6
Hopper capacity, lbs.	4
Cylinder heater, watts	550
Operating range temperature, °F	150-600
Power consumption of heating unit @ 110 volts, amps.	6
Floor space required, in.	26 x 39
Height, in.	71.5
Weight, lbs.	750

The firm manufactures a number of small-size injection molding machines in other series types. Featuring ease of operation, they do not require experienced personnel.

Readers' Service Item E-3

A sign that's

NEW

every day

Changeable letters of Tenite Butyrate keep sales messages fresh and timely

TENITE
BUTYRATE
an Eastman plastic

Changeable letter displays, once found exclusively on theater marquees, have now been adopted by the nation's retailers. They have found that sales, daily specials, current attractions, extra services—a wealth of up-to-the-minute information—can be conveyed to prospective customers through the adaptability of plastic letters.

Tenite Butyrate is playing an important role in the success story of these signs. The brilliant luster, wide color range and outdoor durability of this Eastman plastic have made it the preferred material for effective, eye-catching letters. In Tenite Butyrate, leading sign manufacturers have found a plastic that spells long life for the letters they sell...a material whose toughness cannot be matched by any other weather-durable plastic.

Letters are but one of many applications for Tenite Butyrate in the sign industry. This thermoplastic material can be easily molded, or extruded as sheet and then formed by vacuum, air or mechanical pressure. Because of its high strength, economical lighter gauges often can be used in sign construction.

An ideal material because of its durability, dimensional stability, toughness and workability, Tenite Butyrate is used in outdoor sign applications ranging from letters like those shown above to huge spectaculars 40 feet high. For more information on any use you may have for this strong, versatile plastic, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

Information regarding Tenite also can be obtained from local representatives listed under "Plastics—Tenite" in the classified telephone directories of the following cities: Atlanta, Chicago, Cleveland, Dayton, Detroit, Houston, Kansas City, Leominster (Mass.), Los Angeles, New York City, Portland (Ore.), Rochester (N. Y.), St. Louis, San Francisco, Seattle and Toronto—elsewhere throughout the world, from Eastman Kodak Company affiliates and distributors.

1912—EASTMAN'S 25TH YEAR IN PLASTICS—1957

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MICA FILLERS

Increased strength...high impact resistance...compatible with all resins . . . and best thermal and electrical properties of any mineral filler.

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STERLING BUILDING, STAMFORD, CONN.

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PEARL ESSENCE
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• SYNTHETIC PEARL PIGMENTS to meet the most rigid specifications . . . heat stable, chemically resistant and non-corrosive. • NATURAL PEARL ESSENCE derived from fish scale guanine of the highest quality, to provide maximum luster, brilliance and coverage.

A PRODUCT FOR EVERY TYPE OF PLASTIC

Constant research and development offer you the very best pearlescent pigments on the market. Many completely new products have been developed over the past year. Chemical laboratory control coupled with extensive production facilities assure you of uniform high quality at a remarkably low cost.

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East 21st and East 22nd Sts.
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Manufacturers of Pearl Essence exclusively
Plants: Maine • New Jersey • Canada

Model 3RB Thermex preform heater.

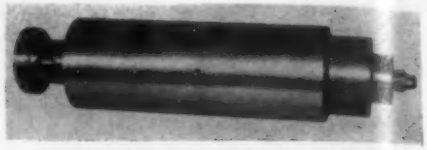
Plastics Perform Heating Unit

A preform heating unit for plastics has been developed by the Thermex division of Girdler Co. Called 3RB, the new model includes an improved electronic circuit which increases electrode voltage. This permits the rapid heating of small preform loads without sacrificing the over-all power output of the unit.

General-purpose phenolic preforms weighing nine ounces can be heated from 80-250° F., in 15 seconds. The unit will take a maximum load of 2½ pounds through the same temperature range in 60 seconds. An electrical heating-cycle control was developed for critical control of the final preheat temperature of such sensitive materials as ureas and melamines. This device permits the delivery of uniformly-heated loads, independent of variations in moisture content, initial temperature, and density.

Output rating of the 3RB is three kilowatts. Its 10- by 12-inch electrode can be raised to accommodate a load of preforms up to 3¾ inches in height. A snap-in holder permits the changing of air filters while the unit is in operation. The aluminum cabinet is 21 inches wide by 24 inches deep, and stands 53¾ inches high. Net weight is 800 pounds. Girdler makes a full line of electronic heaters, many of which are applicable to the plastics industry.

Readers' Service Item E-4



IMS heating cylinder for Lewis presses.

Replacement Heating Cylinder

An extra-capacity replacement heating cylinder for the old-style four-six-ounce Lewis injection molding machines is available from Injection Molders Supply Co. Due to the new clamping device and the larger die space, the replacement cylinder reportedly enables the machine to compete profitably with the more modern presses.

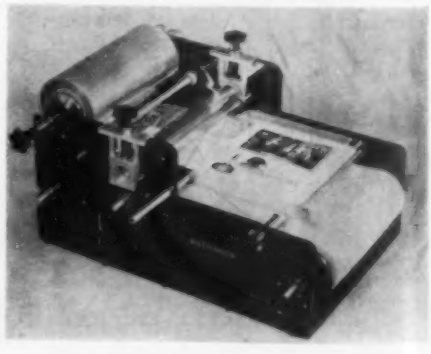
The cylinder measures 22¼ inches, including the nozzle, and is 6½ inches in diameter. This latter figure applies regardless of whether the Lewis 1.3-inch or the 1-⅜ inch oversize plunger is used. It is designed to operate at 50-100° lower than the original equipment, and is said to increase production by 10-30%. Heavier electrical contacts or relays must be employed, since the unit is carrying an added heat of approximately 20,000 watts.

Readers' Service Item E-5

Plastic Film Laminating Unit

A low-cost laminating machine for applying acetate and other plastic films to book covers, displays, record albums, charts, and badges has been introduced by Rotobond Co. Capable of continuous operation, the unit accommodates uncoated films in thicknesses from one mil upwards. Three sizes are available to handle film widths of 12, 18, and 24 inches.

Water-latex dispersions work best with the unit, though solvent-based adhesives can be substituted. The ¼-hp. motor plugs into a standard wall socket. Floor or table space required by the machine is approximately 36 by 36 inches, and the weight is about 100 pounds.



Rotobond laminating machine.

Readers' Service Item E-6

Eastman

PLASTICIZERS

dimethyl phthalate

diethyl phthalate

di-(methoxyethyl) phthalate

di-isobutyl phthalate

di-isobutyl adipate

dibutyl phthalate

di-isooctyl phthalate (DIOP)

dioctyl phthalate (DOP)

dioctyl adipate (DOA)

dioctyl azelate (DOZ)

dioctyl sebacate

dinonyl phthalate

plasticizer 84
-an octyl butyl phthalate

polymeric plasticizer NP-10

triacetin

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For highest quality finished products, rely on Eastman plasticizers — made under the most exacting and rigid specifications in the industry. Samples and technical assistance furnished upon request. Also write for our booklet describing Eastman plasticizers and their uses.

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Kingsport, Tennessee • subsidiary of Eastman Kodak Company

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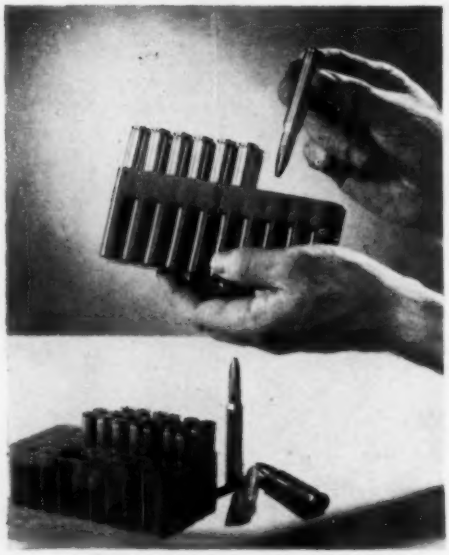
West Coast: Wilson Meyer Co., San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

New Products

Write item numbers on Readers' Service Card to obtain more information.



Amm-O-Safe cartridge boxes.

Polyethylene Ammunition Boxes

Ammunition boxes molded of Eastman's Tenite polyethylene have been placed on the market by Fitz, a manufacturer of shooting accessories. Called Amm-O-Safe, the cases house the shells in individual, shock-resistant compartments.

The boxes are bright red for easy visibility, and can be cleaned with ordinary soap and water. Provided with a slip-on plastic cover, the containers are available in three sizes: Style R, for .222-.375 Magnum rifle cartridge; Style 3, for .222 pistol cartridges; and Style 4, which is designed for .44 or .45 pistol cartridges, may be used as a loading block for all shells up to and including .30-06. Style R holds 20 cartridges, while the other types each hold 50.

Readers' Service Item P-1

Hi-Impact Rigid PVC Sheet

A PVC sheet reportedly possessing great impact strength and rigidity in thin sheets has been introduced into Canada by the plastics division of Canadian Industries, Ltd. The Canadian firm is a sales agent for Imperial Chemical Industries, Ltd., English manufacturer of the Darvic sheeting.

Not a high-frequency insulator, Darvic is reasonably warm to the touch and shows a marked reduction in strength above 60° C. Properties for the sheet, determined at 20° C., are reported as follows:

Density, gms./cc.	1.44
Tensile strength, psi.	7,000-8,000
Punch shear strength, psi.	8,500
Hardness, Brinell	17-18
Thermal conductivity, c.g.s. units x 10^{-4}	4
Coefficient of linear expansion per °C. x 10^{-5}	8
Volume resistivity, ohm-cm.	10^{15}

The sheet can be sawed, sheared, blanked, drilled, turned, milled, tapped, and engraved using a lubricant such as a water-soluble oil or light mineral oil. In forming, the sheet should be heated to about 110-130° C. Allowance should be made for a 2% shrinkage on the first heating.

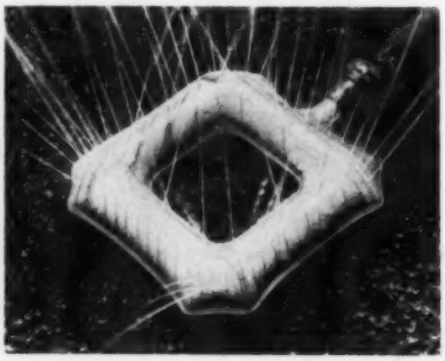
Darvic sheet is available in 12 standard colors, with sizes ranging from 48 by 66 inches to 48 by 72 inches. Thicknesses range from 1/32-½ inch. Sheets normally have a highly polished surface, but a matte finish is available.

Readers' Service Item P-2

Vinyl Lawn Sprinkler

An all-vinyl lawn sprinkler which throws a square spray pattern has been developed by the Resinite department of Borden Co.'s chemical division. Called the Resinite Square Spray Sprinkler, its elasticity permits the device to adjust itself to different water pressures by dilation and contraction of its perforated holes.

Vinyl sheet for the sprinkler is calendered through 7½-inch wide rolls which feed the top and bottom lengths through a set of registration pins to a die which perforates the top side. The top and bottom halves are registered, heat sealed, and die-cut to the final shape. A brass hose coupling is attached by standard methods.



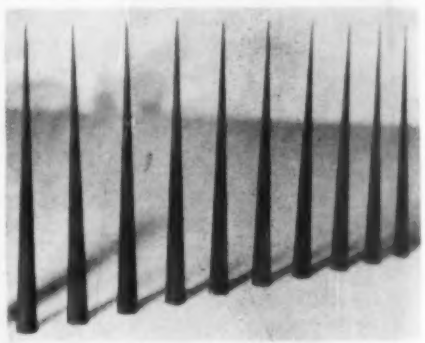
Resinite spray sprinkler

Readers' Service Item P-3

Epoxy Ferrite Absorbers

An epoxy-ferrite rod and sheet series for use in waveguide or coaxial line as absorbers, attenuators, terminals, and loads has been introduced by Emerson & Cuming, Inc. Designated Eccosorb MF, the readily-machinable materials have a high total dissipation factor over the entire microwave frequency range.

In general, step-tapered or uniform-tapered pieces are used as terminations to assure a good match in the waveguide. Eccosorb MF can be used at temperatures up to 175° C., and has negligible moisture absorption. At radio frequencies, the series has been used effectively as a high Q core material for tuning and for magnetic components in general.



Eccosorb MF Waveguide absorbers.

Typical physical properties are reported as follows:

Flexural strength, Psi.	15,000
Impact strength, notched Izod, ft.lbs./in.	0.3
Water absorption, 7 days @ 25°C., %	0.1
Coefficient of thermal expansion, per °C. x 10^{-6}	30
Volume resistivity, ohm-cm^3 x 10^{15}	2
Dielectric strength, V/mil.	380

Readers' Service Item P-4

Transparent Acetate Stickers

Transparent, self-sticking, printed labels called Goodstix Identifiers have been introduced on the market by Goodren Products Corp. Made from 2-3 mil acetate film, the labels are printed in reverse on the adhesive side. This enables them to withstand very rough handling without marring.

Available as continuous rolls, the labels can be used with semi-automatic dispensers or can be dispensed automatically for assembly-line applications The adhesive is pressure sensitive, and is of the common transfer variety. The self-sticking rolls can be slit to desired size, in widths of 1½-8 inches.

Printed acetate display stickers.

Readers' Service Item P-5

Vinyl Enamel Coating

A vinyl enamel coating that can be applied to machinery without interrupting work schedules, has been announced by Wooster Finishes Corp. Called Wooster Vinyl Enamel, the plastic emulsion is non-flammable during application and fire resistant when dry.

The enamel dries to the touch in one hour, is dust free in four hours, and has a non-offensive, non-toxic odor which is not noticeable to workmen in adjacent areas. It dries to a hard glossy finish and in many cases is claimed to outlast conventional oil-base enamels. It is available in one-gallon cans, five-gallon pails, and 55-gallon drums.

Readers' Service Item P-6

Printed Circuit Laminate

A copper-clad laminated plastic designed to meet the specific requirements of radio and television set manufacturers using printed circuits, is being marketed by Formica Corp. Called Cirprint, the laminate is a paper base material bonded with a phenolic resin.

Basically, it is an improved XXP grade which meets Underwriters Laboratory specifications and has the following properties: 250,000 megohm insulation resistance after 96 hours at 90% relative humidity and 35° C.; 0.80% moisture absorption in a one-by three-by 1/16-inch sample after 24 hours immersion; and can be cold punched in thicknesses to 1/16-inch. The material is translucent, water-marked for easy identification, and is available in six sheet sizes ranging from 36 by 42 inches to 36 x 96 inches, and in thickness from 3/64-¼ inch. It is supplied in natural color with a semi-gloss finish.

Readers' Service Item P-7

Two-Quart Polyethylene Beaker

An all polyethylene pitcher with contour handle and tight-seal lid has been introduced by Standfast Products Co. Called the Tight-Seal Pitcher No. 756, the two-quart container has a wide, no-tip base. The handle, integral with the body of the beaker, is produced on a straight mold without cams or other moving parts.

The cap is permanently molded to the lid, and features a non-drip spout. A flexible, ice-cube restrainer prevents splashing. The contained itself is a frosty white color, and the lid can be obtained in turquoise, pink, or lemon.

Polyethylene pitcher shown without lid.

Readers' Service Item P-8

Duro Plastic Aluminum putty dries to a metal-like hardness.

Thermosetting Metal Putty

A thermosetting putty consisting of aluminum particles suspended in a vinyl base has been introduced by Woodhill Chemical Co. Known as Duro Plastic Aluminum, the material is recommended for a variety of do-it-yourself type repairs.

The putty is applied cold with a brush, spatula, or special applicator tube. It requires three or four hours to dry, assuming a metal-like hardness which will permanently bind wood, metals, plastics, glass, or ceramics. If desired, a 20-25 minute cure can be obtained with a heat lamp. Thoroughly dried, it will withstand temperatures to 600° F., and can be carved, planed, drilled, or sawed.

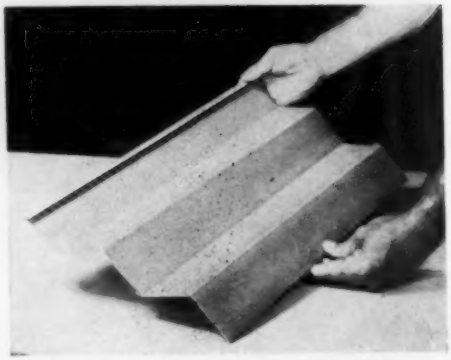
Available in 5½-ounce tubes, and ½-pint, pint, or quart cans, Duro Plastic Aluminum can be applied decoratively to simulate leaded glass windows. It can be used with hardware to produce a rustic or wrought iron effect.

Readers' Service Item P-9

Vinyl Flow-Through Chamber

A chamber for removing tons of moisture and suspended contaminants from the air has proven very useful in large industrial plants. The initial unit of an integrated air conditioning system, the chamber consists of many channels formed by deeply-corrugated vertical walls made from a Geon rigid-vinyl material. The latter material is supplied by B. F. Goodrich Chemical Co.

As the air passes through the channels, the corrugations baffle the flow and allow moisture to condense on the smooth-surfaced walls. Southern Plastics Co. extrudes the interior wall sections of high-impact Geon 8700A. The complete structure weighs so little that no elaborate



Vinyl baffle for plant air conditioning system.

supporting structures are required.

The rigid vinyl sections are immune to moisture and chemical fumes. They have replaced metal parts which were highly susceptible to corrosion, even when coated with protective materials. The smooth-surfaced extrusions inhibit the buildup of deposits which would interfere eventually with the proper flow of air.

Readers' Service Item P-10

Teflon Laboratory Beakers

Laboratory beakers are being molded from DuPont's Teflon tetrafluoroethylene resin by Resistoflex Corp. Available in 250-, 500-, and 1,000-cubic centimeter sizes, the beakers are chemically inert at temperatures up to 500° F., except for molten alkali metals and certain fluorine compounds.

Other features claimed for the beakers are an absence of porosity, which prevents contamination by previously-used materials; low interfacial tension, and high suitability for the recovery of precious metals. The beakers are unaffected by such oxidizing agents as aqua regia and hydrofluoric acids.

Fluorocarbon laboratory beakers.

Readers' Service Item P-11

Impact PVC Pipe Coupling

A pipe coupling of high-impact Koroseal PVC, which can be assembled and disassembled in seconds, has been developed by B. F. Goodrich Industrial Products Co. To install, the grooved end of the pipe is pushed into the coupling until the thrust ring seats in the groove; and to disassemble, a disassembly tool is set in place and the pipe is pulled out of the coupling.

The Koroseal coupling reportedly takes pipe joints which have up to a 10° misalignment. Available sizes include two-, three-, and four-inch in standard 20- and 30-foot lengths.

Easy to disassemble PVC quick-coupling pipe.

Readers' Service Item P-12

Big Bright Butyrate Buoys

Large size buoys of weather-resistant Tenite butyrate are being used by the City of New York to mark off swimming areas at municipal beaches. Highly visible in the water, the markers are made in a lustrous red, yellow, and blue design with the colors an integral part of the plastic.

The balsa buoys used previously required periodic painting; however, the butyrate buoys can remain in service for several years with no maintenance required. Each buoy consists of six molded pieces which are cemented permanently together. An opening through the center provides for stringing the 10-pound units together to rope off a beach area.

Molded butyrate buoy.

Tenite butyrate is a product of Eastman Chemical Products, Inc. The buoys were molded and assembled by Fibro Corp.

Readers' Service Item P-13

Butyrate-Nickel Headset

A new and reportedly improved headset for office, laboratory, and communications equipment is available from Telex. Called the Telex Twinset, it is constructed of Tenite butyrate and nickel. Weight is a mere 1.6 ounces, enabling the wearer to use it for hours at a time with a minimum of discomfort. Butyrate parts, including the receiver housing and the head band covering, are rustproof and practically unbreakable.

The set's magnetic receivers rest on the temples, and are held by a flexible headband which adjusts to any head size or shape. The adjustable tone arms pipe sound directly into the ears, and are capped with butyrate tips. Tenite butyrate is supplied by Eastman Chemical Products, Inc.

Combination butyrate-nickel headset.

Readers' Service Item P-14

New Literature

Write item numbers on Readers' Service card to obtain copies.

"Pipe Facts." Special Issue No. 9. E. I. du Pont de Nemours & Co., Inc. 11 pages. Flexible polyethylene piping, made from Du Pont's Alathon 25, is discussed in this illustrated booklet.

Readers' Service Item L-1

"Plastic Molding." Waterbury Cos., Inc. 3 pages. This brochure describes the company's facilities for compression, transfer, and injection molding; as well as the associated operations of mold making, engineering, design, research, and assembly.

Readers' Service Item L-2

"Chemical Processing Machinery." Bulletin No. 557. J. H. Day Co. 4 pages. Day mixers, sifters, blenders, and roll mills are described in this bulletin. Design features and specifications of the various models are tabulated.

Readers' Service Item L-3

"Butanol." Union Carbide Chemicals Co. 11 pages. Physical properties of butanol as well as its behavior when used as a resin or plasticizer intermediate are discussed in this bulletin.

Readers' Service Item L-4

"Dry Processing Equipment." Sturtevant Mill Co. 8 pages. Information on crushing and grinding machines, air separators, and laboratory reduction mills is given in this illustrated booklet.

Readers' Service Item L-5

"Vidigage Thickness Tester." Bulletin V-302. Branson Instruments, Inc. 2 pages. This leaflet discusses how internal discontinuities in regularly shaped plastics items are detected with the Vidigage unit.

Readers' Service Item L-6

"How To Choose an Extruder." Bulletin E-3. Prodex Corp. 50 pages. An engineering analysis of current extruder design is contained in this booklet, in addition to information on extrusion techniques and methods.

Readers' Service Item L-7

"Lustrex Hi-Test 88B Extrusion Material." No. 2346. Monsanto Chemical Co. 3 pages. This bulletin describes extrusion techniques, storage, predrying, applications, and finishing methods for the company's high impact styrene compound. Mechanical, thermal, physical, and electrical properties of the material are tabulated.

Readers' Service Item L-8

"Marvel Series Material Granulators." Ball & Jewell, Inc. 3 pages. Five standard granulator models, as well as optional equipment and accessories, are described in this illustrated leaflet.

Readers' Service Item L-9

"Silva-Lume." Sylvania Electric Products, Inc. 5 pages. This bulletin discusses the use of translucent vinyl paneling to create pattern, color, texture, mood, and style, in wall-to-wall lighting.

Readers' Service Item L-10

"Properties Of The Paraplex P-Series Resins." Rohm & Haas Co. 32 pages. This booklet describes the company's styrene—and acrylic-modified polyester resins, and lists the post-cure properties of both the reinforced and unreinforced types.

Readers' Service Item L-11

"Reinforcement and Fabrication of the Paraplex P-Series Resins." Rohm & Haas Co. 14 pages. Glass cloths, mats, and rovings are discussed, as well as various lamination and molding methods.

Readers' Service Item L-12

"Plastics Hi-Lites." Hercules Powder Co. 16 pages. This pamphlet contains a progress report on Hi-Fax, the company's ethylene polymer produced by the Ziegler low-pressure process. Applications to housewares, packaging, and toys are discussed.

Readers' Service Item L-13

"Curing The Paraplex P-Series Resins." Rohm & Haas Co. 22 pages. Reactivity, catalysts, accelerators, and the effect of fillers, pigments, and dyes are described in this booklet. Physical properties of filled and unfilled resins are tabulated, and graphs and charts are used to augment the discussion.

Readers' Service Item L-14

"Diall." Mesa Plastics. 7 pages. The company's line of diallyl phthalate molding compounds are described. Molding data, electrical properties, and physical characteristics of the finished product are listed.

Readers' Service Item L-15

"Garan Woven Roving." L.O.F. Glass Fibers Co. 6 pages. This illustrated folder describes the properties and applications of Garan, a woven fabric made from bundles of parallel glass fibers preimpregnated with clear or pigmented resin.

Readers' Service Item L-16

"Urethane." Technical Bulletin No. 5. Food Machinery and Chemical Corp. 6 pages. A summary of the chemical reactivity and potential uses of urethane is given in this pamphlet.

Readers' Service Item L-17

"Molding Systems." Molding Systems Inc. 4 pages. This illustrated brochure describes the various features of the Battenfeld automatic injection molding machine. Physical details of 17 models are tabulated.

Readers' Service Item L-18

"Viscorator, Continuous Plant Stream Analysis." Catalog 15A100. Fischer & Porter Co. This bulletin describes an autosampling device which continuously measures and records both the temperature and the temperature-compensated viscosity of liquids flowing in process piping.

Readers' Serviee Item L-19

"New Plastolein 9078." Emery Industries, Inc. 8 pages. Performance characteristics of Plastolein 9078, a low temperature plasticizer for vinyls, are compared with those of several adipates.

Readers' Service Item L-20

"Diamond Precipitated Calcium Carbonates For Polyvinyl Chloride Applications." Diamond Alkali Co. 16 pages. This bulletin presents data on filler requirements, plant processing considerations, physical properties of vinyl compounds, basic stock formulations, and plasticizers. The characteristics of eight Diamond inert fillers are reviewed.

Readers' Service Item L-21

Book Reviews

"The Encyclopedia of Chemistry." Edited by George L. Clark and Gessner G. Hawley. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 6¾ by 9¼ inches, 1,053 pages. Price, $19.50.

One of the most complete reference works ever compiled and published in one volume, the book atempts to achieve an over-all unity rather than present a series of unrelated facts and data. Over 500 distinguished chemists collaborated to make it both comprehensive and up-to-date, and the editors have done a particularly good job in avoiding repetition and overlapping.

Topics selected for inclusion deal primarily with chemistry proper; however, this term is broadened to include processing, control, annealing, abrasion resistance, electron tubes, and instrumentation. Chemical engineering is covered in both basic theory and unit operations. The scope of such allied sciences as potentiometry, meteorology, metallurgy, and bacteriology is summarized. Many formulas, tabulations, and cross references are included.

Effect of Moisture Sorption on Weight and Dimensional Stability of Alkyd Isocyanate Foam Core." V. C. Setterholm and E. W. Kuenzi, Forest Products Laboratory, for Wright Air Development Center. Order PB 121800 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 34 pages. Price, $1.00.

This study was conducted to enable research workers to predict the adverse effects of high-moisture conditions on alkyd-isocyanate foam cores, which are used as structural sandwich materials in aircraft and missiles. Cores were immersed in water and exposed to high humidity for 60 days. Results indicated few differences between alkyd-isocyanate foamed in blocks without facings and those foamed between two facings to make sandwich constructions. Exposure to high humidity brought about weight increases as high as 4%, and dimensional increases of 0.7%.

"The Industrial Chemistry, Properties, and Application of Silicones." Charles E. Reed. American Society of Testing Materials, 1916 Race St., Philadelphia 3, Pa. Paper, 6 by 9 inches, 50 pages. Price, $1.50.

The Edgar Marburg Lecture of 1956, this paper was presented at the 59th annual meeting of the Society. Very comprehensive in scope, it covers the chemical and molecular structure of the silicones. The basic material is an organo-chlorosilane, from which can be derived fluids (emulsions, greases, and oils); resins (varnishes, adhesives, and molding powders); and elastomers (molding compounds, extrusion materials, coatings, and gum).

The manufacturing process for methylchlorosilanes, silicone oils, and silicone greases are explained in graphic form. Many photographs of parts and equipment are included with tabular data and charts. References are quoted.

"Analysis of the Thermal Properties of Plastic Laminates, Cores, and Sandwich Panels." R. F. Trapp, Wright Air Development Center. Order PB 121882 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 18 pages. Price, 50¢.

Data from previous research were analyzed to provide engineers with thermal properties of materials on which specific data are not readily available. Plastic materials then can be evaluated for structural use at high temperatures. Mean curves representing the resin types for specific heats, thermal expansion, and thermal conductivity are included.

"Polymer Evaluation Handbook." C. H. Adams, Monsanto Chemical Co., for Wright Air Development Center. Order PB 121870 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 119 pages. Price, $3.00.

Purpose of this manual is to standardize polymer evaluation work in the laboratories of Air Force contractors, and to aid in the training of inexperienced technical personnel. Background information is included on the principles of evaluation, properties, measurements and their significance, nature and behaviour of polymers, and the physical characteristics of plastics.

"Engineers Employed by Private Practitioners." National Society of Professional Engineers, 2029 K St., N.W., Washington 6, D. C. Paper, 6 by 9 inches, 40 pages. Price, $1.00.

This work is a nation-wide survey report on the status of engineers employed by consulting firms. Basic information is provided on salaries, hours, geographic distribution of employes, firm size, fringe benefits, length of workweek, and overtime pay practices. Data was obtained from questionnaires which the Society had sent to the various consulting firms.

"Manufacturing Processes—Fourth Edition." Myron L. Begeman. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Cloth, 6 by 9¼ inches, 624 pages. Price, $8.00.

Stated purpose of this book is to provide engineering students with a basic knowledge of materials, processes, and manufacturing operations. It is also useful to the practicing engineer, and will aid the industrial worker who wants to review a special phase of metal processing.

Line drawings are used, whenever possible, to illustrate each machine process. New chapters include Manufacturing Processes, Electroforming & Metal Coating Processes, and Metal Cutting; completely written chapters are those on Foundry Equipment & Procedures, Press Work, Plastic Molding, Inspection, and Drilling & Boring Machines.

"Systematic Organic Chemistry." Hugh C. Muldoon and Martin I. Blake. McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y. Cloth, 6¼ by 9¼ inches, 836 pages. Price, $7.75.

Designed as a textbook for the general student, it serves the dual function of providing the beginner with a sound basic knowledge of the subject and a basis for further study. Where feasible, factual matter is confined to tables so that newer theories can be given a more extensive treatment. Modern ideas of bond formation, pure and hybrid bonds, and new interpretations of the double and triple bond are included.

The reader learns not only what takes place in a reaction but, to an extent, how and why it occurs. Chief emphasis is on principles and their applications; however, practical procedures are not overlooked. The book is very readable, and features a clear, direct style. There are liberal cross references, structural formulas, illustrations, and tables. Exercise questions are included at the end of each chapter.

"ASTM Standards on Plastics." American Society for Testing Materials, 1916 Race St., Philadelphia, Pa. Paper, 6 by 9 inches, 871 pages. Price, $6.00.

Sponsored by ASTM Committee D-20 on Plastics, the work contains specifications, methods of testing, nomenclature, and definitions. Among the more specific headings are the following: specifications for molding compounds and base materials, testing of standard and molded shapes, mechanical properties, thermal properties, optical properties, permanence properties, analytical methods, molds, electrical tests, and molding processes. Contents also are listed in numerical sequence.

Specifications for materials are handled in the following manner. Scope defines the limitations of the formulations covered by the given ASTM designation. Types and grades are covered, along with general and detail requirements for the material. Sampling conditions are defined, and the methods of testing are enumerated. Methods for reporting test results are covered.

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Abstracts of Important Articles

Materials

Vinylidene Chloride with Mixed Azo-inorganic Peroxide Catalyst. No. 2,776,273. Antoine P. Richard, Villeurbanne, France (to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny & Cirey, Paris, France).

A method of producing copolymers of vinyl chloride and vinylidene chloride, which consists of forming an aqueous emulsion of the two substances together with a plurality of catalysts, one of which must be an azo polymerization catalyst while the other must be an inorganic peroxide catalyst.

Solutions of Formaldehyde Polymers. No. 2,775,570. Archie E. Barkdoll, Hockessin, Wilmington, and Robert N. MacDonald, Wilmington, Del. (to E. I. du Pont de Nemours and Co., Wilmington, Del.).

Macromolecular polyoxymethylene, having an inherent viscosity of 0.6, is dissolved in an aromatic hydroxy compound.

"From Cork to Polyethylene: Evolution of the Stopper," M. Parducci, *Mat. Plastiche*, 22, 1, 65 (Jan. 1957).

Stoppers, caps, and other closures made from polyethylene are described, as well as the way they solve problems of hermetic sealing, hygiene, and appearance. (In Italian).

"Micromorphology of Synthetic Fibers," J. Isings, *Plastica*, 10, 1, 32 (Jan. 1957).

Studies on nylon and other synthetic fibers with the polarizing and contrasting-phase microscopes revealed local variations in birefringence values. In the case of Dacron, Orlon, Acrilan and PVA fibers, local lack of homogeneity in density caused fibrillation during torsion fatigue experiments, thus indicating loss of strength. This situation can have considerable influence on the physico-mechanical properties of synthetic fibers. (In Dutch).

"Diffraction Gratings on Plastic Foils and Possible Applications," I. Grave, *Kunststoffe*, 47, 3, 113 (Mar. 1957).

A cheap and simple method for producing grating impressions on the surface of thermoplastic foils employs hot forming and the use of metal-diffraction gratings as matrices. Vacuum metallization of the plastic copies of gratings increases the relectivity of the surface. The copies are characterized by a peculiar color dispersion which can be regulated by producing lines on the matrix. Suggested applications include watch dials, advertising matter, colored windows, jewelry, cigarette boxes, etc. (In German).

"Condensation Tests on B-Naphthol with Aldehydes," W. Strubell, *Plaste u. Kautschuk*, 3, 12, 280 (Dec. 1956).

Beta Naphthol reacted with aldehydes behaves quite differently from phenol. Resins were obtained only in two cases from an isolated intermediate product when hexamethylenetetramine was added. (In German).

Equipment

"Problems in the Selection of Extruder Screws," Robert Sackett, *SPE J.*, 13, 6, 30 (June 1957).

An SPE Conference paper discussing screw variables, the single-screw extruder, the metering section, screw dimensions, compression ratio, operating characteristics, thermal control, mixing, end effects, and use of screen packs.

"Temperature Control for Platen Presses" J. C. Stansel, *SPE J.*, 13, 7, 15 (July 1957).

An SPE Conference paper in which proper instrumentation and attention to critical control points are shown to be necessary for maximum production of a platen press. Factors mentioned are control limits, pressure, platen dimensions and components, plates, padding, thermocouples, and materials.

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in December.

"Tooling for Injection Molding," N. C. Taylor, *Western Plastics*, 4, 6, 21 (June 1957).

Design factors for an injection mold are discussed. Mention is made of the effects of shape and size of runners; land length, shape, and size of gates; slug molding; tab gating; and tunnel gating.

Processing

"Relationships Between the Hydraulic System and Polymer Flow in Molding," O. M. Hahn, *SPE J.*, 13, 7 ,25 (July 1957).

This is an SPE Conference paper in which the interdependence of polymer characteristics, heating cylinder, mold design, and hydraulic system is discussed, with particular emphasis on the characteristics of the hydraulic system.

"The Holofol Process," Walter Opavsky, *SPE J.*, 13, 8, 47 (Aug. 1957).

A brief description of the Holofol Process for making seamless hollow articles from plastic materials, cellulose derivatives, and both natural and synthetic rubbers.

"Significant Variables in Plastic Container Fabrication," R. J. Lee and J. W. Mighton, *Western Plastics*, 4, 7, 19 (July 1957).

Variables discussed include injection speed, plastic temperature and packing, mold construction, molding economics; and for vacuum forming technology, the forming technique, sheet quality, mold size, trimming, and the influence of the process on the containers.

Applications

"Plastic Rotor Blades for Turbojet Engines," John Kulp, *SPE J.*, 13, 6, 27 (June 1957).

An SPE Conference paper describing how reinforced plastic rotor blades can be used for the J-47 turbojet engine.

"Silicon Polymers as High-Temperature Insulation for Miniature Power Transformers," F. T. Parr, *SPE J.*, 13, 8, 19 (Aug. 1957).

Properties of organosilicon materials are given and shown to meet the special

high-temperature electrical insulation requirements of miniature power transformers.

"Casting Resin Applications in Electronic Equipment," K. A. Fletcher, *Brit. Plastics,* 30, 3, 90 (March 1957).

The different casting resins used for potting, encapsulating, and embedding electronic parts are discussed. The difficult electrical and temperature requirements are described in terms of specific applications. Assembly problems and mold design are covered.

"Plastics and Radioactive Metallography," E. C. Sykes, *Brit. Plastics,* 30, 3, 95 (March 1957).

The complex, remotely-operated equipment for radioactive metallurgy at the Atomic Energy Research Establishment, Harwell, makes extensive use of plastics. The way in which polyethylene, in particular, but also methacrylates, PVC, glyptal resins, and Terylene velvet are employed in such an installation is described in some detail.

"Utilization of Polyamides," F. Mailly, *Ind. Plastiques Mod.,* 9, 4, 1 and 9, 5, 18 (April & May 1957).

This article describes the different types of polyamides and interpolyamides, the qualities which make them suitable for specific purposes, and their processing methods. (In French).

"1956 Report of the Plastics Standards Section (FNK) of the German Standards Committee," A. Hochtlen and G. Ehlers, *Kunstoffe,* 47, 4, 159 (April 1957).

This report on activities and developments in German plastics standards is a continuation of the 1955 and earlier reports. Included are 54 references. (In German).

General

"Reinforced Plastics and Road Transport," M. D. Curwen, *Plastics (London),* 22, 233, 49 (Feb. 1957).

Raw materials (glass fibers and polyesters) are described in general terms, along with the methods employed in producing reinforced plastic structures. Some of the difficulties encountered by beginners in this field are covered, as are hazards to plant and personnel. The need for developing scanning methods for evaluating impregnation is pointed out.

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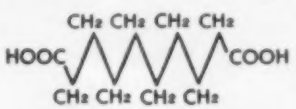

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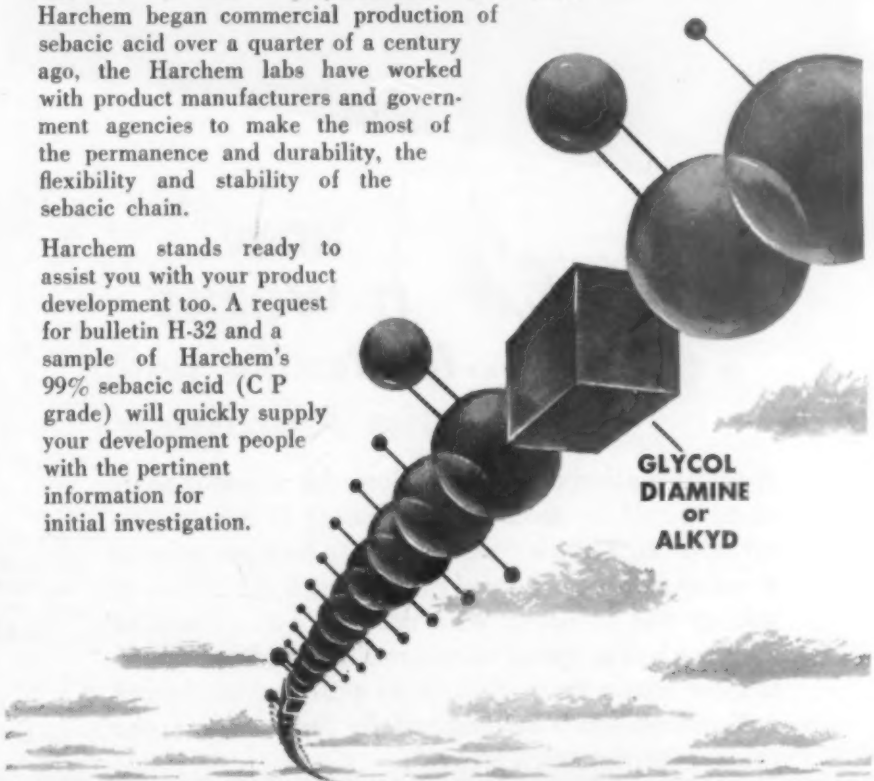

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"Scale for Calculating the Interior Coating of Piping," H. Gut, *Kunststoff-Rundschau,* 4, 1, 16 (Jan. 1957).

A scale for rapidly calculating the weight and volume of dry interior pipe coatings is explained. The following factors must be known: the interior diameter of piping, thickness, and specific gravity of the dry film. The thickness of wet film and amount of shrinkage also can be calculated. (In German).

"Properties and Principles of Calculating Plastic Piping," H. Gut, *Plastverarbeiter,* 7, 12, 464 (Dec. 1956).

Applications of rigid PVC, and both high- and low-pressure polyethylene piping are given, along with tables of their physical properties. An abstract from the Standards proposed by the Subcommittee ISO/TC 5/C6 for Plastic Piping, at Zurich, in March 1956 is presented, as are scales for checking wall-thickness of pipe and nominal pressures. (In German).

"Remarks on the Casting of Injected Parts," J. Combette, *Ind. Plastiques Mod.,* 9, 4, 28 (April 1957).

Formulas are given for calculating the cost of producing injection moldings, along with the effects of a change in cycling time on the price.

"Supersonic Degradation of High Polymers," G. Wilke and K. Altenburg, *Plaste u. Kautschuk,* 3, 10, 219 and 3, 11, 257 (Oct. and Nov. 1956).

Literature review of experimental and theoretical investigations on the supersonic degradation of high polymers It includes 158 references. (In German).

"Epoxy Resins in Patent Literature," G. Tewes, *Kunstoff-Rundschau,* 4, 2, 41; 4, 3, 87; and 4, 4, 143 (Feb., Mar., and April 1957).

Epoxy resins and their method of selection are explained. The patents are considered under the following heads: general production and processing methods; epoxy resins containing halogen and thio groups; curing and cross-linking; esterification; reaction with monomeric, polymerizable, unsaturated compounds; cellular materials; and their combinations with other compounds (aldehyde-condensation products such as amines, phenoplastics, polyester resins, organo-silicon compounds, vinyls, acrylics, and pitches). Certain reactions of epoxy compounds are mentioned to illustrate new possibilities, and a few proposed uses of epoxy compounds as stabilizers and plasticizers are added. There are 247 references. (In German).

Patent Digest

Materials

Production of Polyvinyl Acetate Beads and Emulsions. No. 2,782,173. John E. Bristol and Edward P. Czerwin, Niagara Falls, and Norris Turnbull, Grand Island, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Vinyl Acetate is polymerized in the presence of a catalyst to a solids content of about 30% by weight, after which it is mixed with an aqueous solution of polyvinyl alcohol. The unreacted vinyl acetate is recovered by distillation.

Dispersions of Perfluorocarbon Polymers. No. 2,782,174. Alexander C. Hetherington, Mountainside, and Wilber O. Teeters, River Edge, N. J. (to M. W. Kellogg Co., New York, N. Y.)

A composition comprising finely-divided, solid particles of plastic polytrifluorochloethylene and not more than 20% by weight of a substantially non-solvent, normally-liquid dispersing medium.

Method of Producing a Solidified Cured Resin. No. 2,783,214. Edward C. M. Homan, Montclair, N. J. (to Cordo Chemical Corp., Norwalk, Conn.).

A solidified, cured resin is produced by mixing together, in the presence of a catalyst, a curable epichlorohydrin-bisphenol reaction product and a curing agent consisting of 95-75% triethylene tetramine and 5-25% of triethanolamine. An exothermic, spontaneous curing reaction results.

Manufacture of Fluorine Containing Polymers. No. 2,783,219. Herbert J. Passino, Englewood, and Albert L. Dittman, North Bergen, N. J., and John M. Wrightson, Whittier, Calif. (to M. W. Kellogg Co., Jersey City, N. J.).

Trifluorochloroethylene is polymerized at a temperature between 0-20° C., and in the presence of an aqueous suspension medium containing an alkali persulfate, and alkali bisulfite, and water-soluble liver salt.

Cross-Linked Copolymers of an Acrylic Acid as Cation Exchanging Resins. No. 2,783,212. Hermann Schnell, Leverkusen-Wiesdorf, Germany. (to Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany).

A water-insoluble resin capable of exchanging cations in a liquid medium is prepared by copolymerizing, in the presence of a catalyst, a water-soluble organic acid with an organic compound having at least two polymerizable double bonds. The resulting copolymerizate is condensed with a compound selected from the group consisting of polyhydric alcohols, polyamines, and aldehydes.

Surface Coatings of Solutions of Furfural-Modified Hydrolyzed Vinyl Acetate-Vinyl Chloride Copolymers. No. 2,782,175. Paul F. Bruins, Brooklyn, N. Y., and Stephen S. Dorn, North Arlington, N. J. (to Caroline Co., St. Louis, Mo.).

A copolymer of vinyl chloride, vinyl acetate, and vinyl alcohol is dissolved in a solvent containing furfural to produce a reaction product containing acetal groups and unreacted furfural. The modified solution is sufficiently stable for storage in closed containers.

Hydrolysis of Polyvinyl Esters. No. 2,783,218. William L. Kuechler, Grand Island, N. Y. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Preformed, solid-phase polyvinyl acetate is converted directly into solid-phase polyvinyl alcohol by subjecting the former to aqueous hydrolysis in the presence of an insolubilizing agent for the polyvinyl alcohol.

Polymer Separation Method for Calcium Polyacrylates. No. 2,782,183. Reginald N. Gonzales, Holyoke, Mass. (to Monsanto Chemical Co.)

A solid, pulvurulent calcium salt of a hydrolyzed acrylonitrile polymer is prepared by precipitating a salt to form a suspension in an aqueous medium. The suspension is filtered and the precipitate is dried at a temperature above 75° C.

Flame Retardant Polyester Resinous Compositions Containing Halogen. No. 2,783,215. Paul Robitchek, Buffalo, and Claude Thomas Beane, Jr., Niagara Falls, N. Y. (to Hooker Electrochemical Co., Niagara Falls, N. Y.).

A polymerizable mixture consisting of a linear polyester, a compound containing aliphatic carbon-to-carbon unsaturation comprising an adduct of hexahalocyclopentadiene, and a compound containing aliphatic carbon-to-carbon unsaturation; wherein the halogen is selected from the group consisting of chlorine, fluorine, bromine, and mixtures thereof.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Halogen Containing Vinylidene Resins Stabilized With a Mixture of Zinc and Calcium Salts of Phenyl Carboxylic Acids. No. 2,782,176. Joseph R. Darby, Webster Groves, and Leo D. Frederickson, Jr., St. Louis, Mo. (to Monsanto Chemical Co., St. Louis, Mo.).

A halogen-containing vinylidene resin, stabilized by a zinc salt of a phenyl mono carboxylic acid and a calcium salt of a phenyl carboxylic acid, forms a composition which is resistant to the discoloring effects of heat.

Laminating Composition and Laminate Made Therefrom. No. 2,784,128. Juel P. Schroeder, Springfield, N. J. (to Union Carbide Corp., New York, N. Y.).

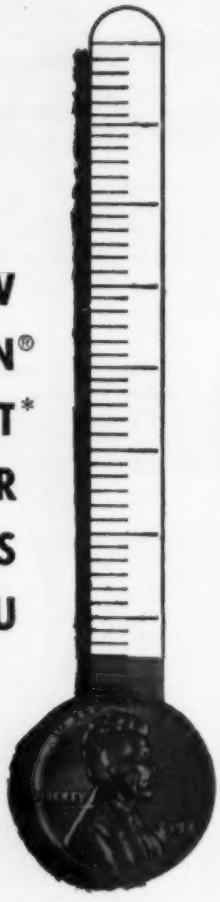
A thick, stable, creamy, aqueous emulsion particularly adapted to preparing laminates of superior electrical properties and moisture resistance comprises a styrene-acrylic acid polymer; a 1,2-epoxy-containing polyether of a polyhydric alcohol; and a small amount of a polyacrylic acid wetting agent. The laminate comprises a base impregnated with a styrene-acrylic acid emulsion, and a diglycidyl ether of a di-phenol.

Purification of Vinyl Acetate. No. 2,784,149. Stephen S. Dorn, North Arlington, N. J., and Charles William Fairbanks, Wilmington, Del. (to E. I. du Pont de Nemours and Co., Wilmington, Del.).

Raw vinyl acetate containing unsaturated organic compounds is admixed with an organic, cyclic, thiol compound. The resulting mixture is distilled, and the vinyl acetate is recovered.

Liquid Compositions Comprising a Nitrogenous Polymer. No. 2,784,166. Henry P. Wohnsiedler, Darien, Conn., and Edward L. Kropa, Columbus, O. (to American Cyanamid Co., New York, N. Y.).

A liquid composition comprising by weight a major proportion of water and a minor proportion of a polymer, obtained by maintaining a polyethylene-melamine in contact with acidic water until it has polymerized to the desired degree. The polyethylene-melamine is a polyamino-s-triazine, wherein at least two of the amino nitrogen atoms are attached to an ethylene group instead of the two hydrogen atoms.



NEW PLASTOLEIN® 9078 LT* PLASTICIZER GIVES YOU

low-temperature flex and low cost!

Properties superior to adipates, yet in same price range

New Plastolein 9078 LT Plasticizer possesses an outstanding combination of properties that makes it very attractive as an economical low-temperature plasticizer. A unique product derived from Emery's Ozone Oxidation Process, Plastolein 9078 offers many advantages over the adipates, including better low-temperature flex, volatility, increased compatibility, lower mineral oil extraction, and higher efficiency.

If you are now using an adipate, check the advantages that Plastolein 9078 can impart to your product. Mail coupon below for descriptive literature, an evaluation sample, or a visit from one of our technical representatives.

*Low temperature

Comparison of Plastolein 9078 with di-decyl adipate

Plastolein 9078		DDA	Plastolein 9078		DDA
Parts Geon 101	100	100			Borderline
Parts Plasticizer	48	49	Masland Impact, °C	—40	at —40
Tensile, psi	2650	2400	Extraction, mg/in²		
Elongation, %	365	360	Water, 24 hrs. @ 50° C	0.2	0.1
Modulus, 100%, psi	1130	1240	Soapy Water, 24 hrs.		
Hardness, D.10 sec.	85	89	@ 50° C	1.0	0.4
Volatility, SPI, 70° C			Min. Oil, 24 hrs. @		
1 day-mg/in²	1.9	2.3	25° C	11.1	19.8
7 days-mg/in²	8.0	9.1	Compatability, Roll		
			Spew	Slight	Severe

Organic Chemical Sales Department

Emery

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Cincinnati 2, Ohio

Emery Industries, Inc., Carew Tower,
Cincinnati 2, Ohio. Dept. Q10A

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- ☐ Please send a pint evaluation sample
- ☐ Please send a technical representative

name.....*title*.....
company.....
address.....
city.....*state*.....

Equipment

Apparatus for Molding Material. No. 2,783,500. Thaddeus R. L. Lazar, Greensboro, N. C. (to Western Electric Co., Inc., New York, N. Y.).

The apparatus consists of a mold with a fixed part adapted to receive a heated plastic sheet, and a moving part is secured to an elastic covering sheet. A hermetic seal is formed between the two parts, thus capturing the heated air above the plastic sheet and creating a molding pressure.

Fiber Forming Apparatus. No. 2,783,590. Charles J. Stalego, Newark, O. (to Owens-Corning Fiberglas Corp., New York, N. Y.).

A container for molten glass communicates with a hollow tubular body having an opening in its lower end, and a plurality of radial vanes attached to its inner wall. The vanes extend axially through part of the body and beyond the open lower end to absorb heat from the glass and conduct it to the wall.

Means for Pneumatically Conveying Plastic Particulate Material. No. 2,784,038. George Schneider, University Heights, O. (to Dracco Corp., Cleveland, O.).

A plurality of wrinkles are formed on the internal surface of a low-pressure pneumatic conveyor conduit to interfere with continuous sliding surface contact with the plastic material being conveyed. A means also is provided to maintain an abruptly-descending velocity gradient between the main body of the airstream and the walls.

Threading Tool for Plastic. No. 2,783,485. Harley E. Noland, Akron, and Herbert E. Hankey, Mogadore, O.

A thread cutting device comprises a frame member with a pair of angularly-disposed supporting plates; a longitudinally-extending guide means provided on one of the plates; a thread-cutting die receivable in the guide and permitting longitudinal movement therein; and a mandrel rotatably-carried by the second plate. The mandrel and the cutting die are in threaded engagement in such a manner that, upon rotation, the die will be advanced axially of the mandrel to make cutting engagement with the tubing.

Processing

Plastic Covered Insulation Product and Method for Producing Same. No. 2,782,465. George Bruce Palmer, Jr., Grosse Pointe, Mich.

A temperature-insulating material having the shape and dimensions of a refrigerator door is enclosed within a permeable, flexible envelop which is impreg-

nated and coated with a thermoset plastic composition. The thermoset plastic is cured under heat and temperature to provide a rigid, finished door.

Method of Making Laminated Tubing. No. 2,783,173. Benjamin M. Walker, Caldwell, and Alexander N. T. St. John, Glen Ridge, N. J. (to Resistoflex Corp., Roseland, N. J.).

A purality of fabric layers inpregnated with fluorocarbon resin are wrapped on a mandrel and tightly covered with a layer of glass fabric tape. The assembly is heated to sintering temperature to fuse the adjacent, resin-impregnated surfaces. After the laminate is cooled, it is removed from the mandrel in the form of a reinforced, fluorocarbon resin-impregnated pipe.

Method of Laminating Plastic Materials. No. 2,783,176. James H. Boicey, Toledo, O. (to Libbey-Owens-Ford Glass Co., Toledo, O.).

At least one sheet of polyvinyl butyral is sandwiched between two sheets of acrylic, and enclosed in a plastic bag from which the air has been evacuated. The bag and contents are put into a hot liquid bath to form a laminated unit which, upon removal, is oven-dried to remove wrinkles.

Applications

Plastic Impeller. No. 2,782,722. Horace A. Chubbuck, Belleville, Mich. (to Ford Motor Co., Dearborn, Mich.)

A pump impeller comprising a hub-supported body provided with a series of radial channels separated by bifurcated radial blades. A plurality of holes through the body are located at points intermediate between the hub and body periphery. Alternate bifurcated blades are of uniform thickness in an axial direction, while the intermediate blades are reduced in axial thickness near the hub.

Polyurethane Cushions. No. 2,785,739. William A. McGregor, Jr., St. Louis, and James D. Mahoney, Ferguson, Mo. (to Mobay Chemical Co., St. Louis, Mo.).

A foamed polyurethane seat cushion features a plurality of grooves which are wider at the top than at the bottom.

Laminates and Laminated Products. No. 2,782,976. Anthony J. Rinaldi, Demarest, and Francis A. Romano, Englewood, N. J.

A combined baking, shipping, and merchandising receptacle for goods, the container is fabricated of a laminate comprising a semi-rigid cellulosic base, a layer of moderately-parchmentized material containing a stearyl releasing agent, and a PVA adhesive.

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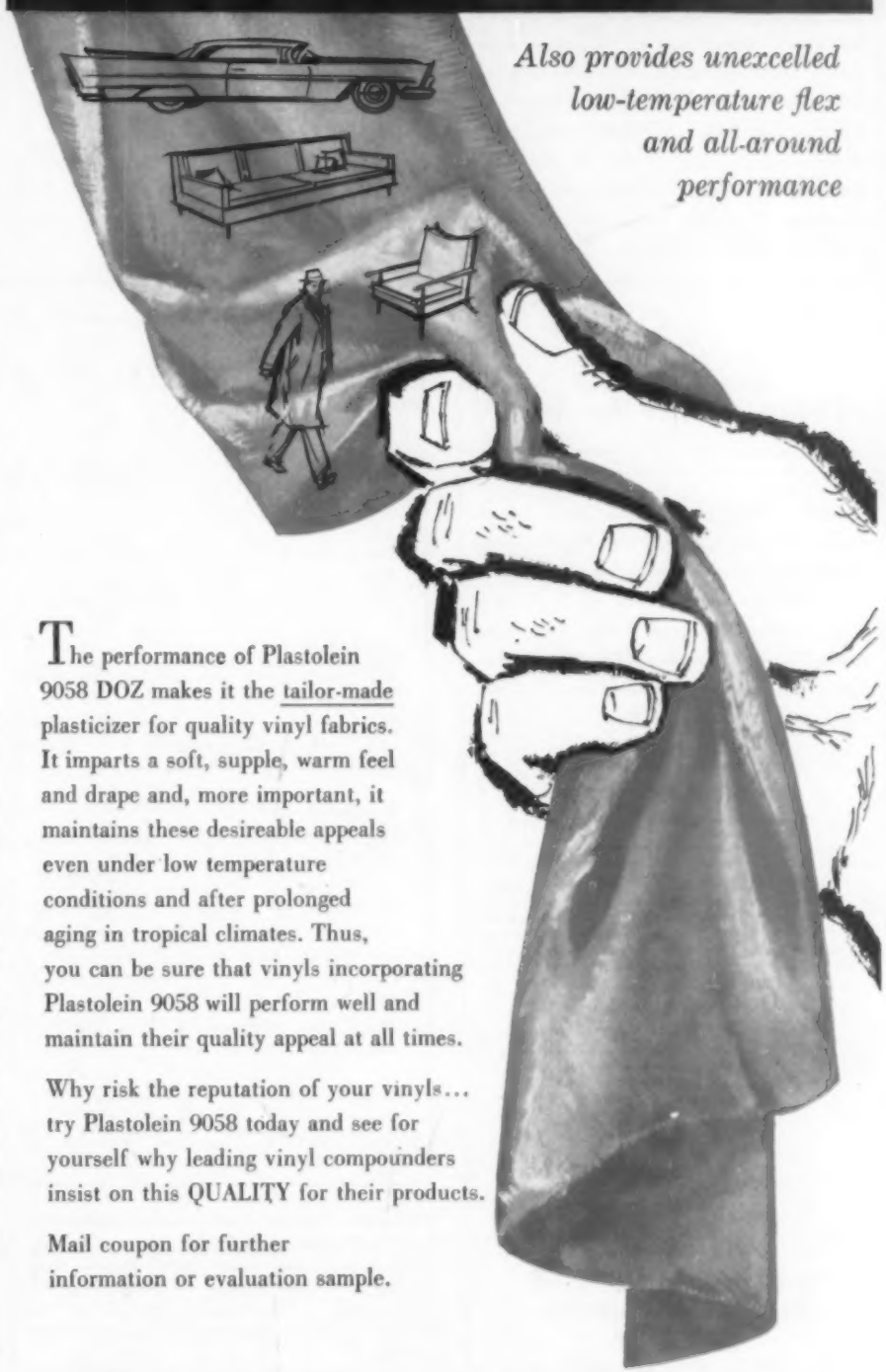

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Price Changes and Additions

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Dispersant A	*lb.*	.75 /	1.00

Resins & Molding Compounds

Fluorocarbon

Polyfluoron, high density pellets, grades HT, MT, LT	*lb.*	6.50 /	9.00
colored	*lb.*	7.00 /	9.50
Low density pellets, clear grades HT, MT, LT	*lb.*	6.00 /	8.50
colored	*lb.*	6.50 /	9.00
Mikron-atomized powder, clear dispersion grades HT, MT, LT	*lb.*	8.00 /	10.50
colored	*lb.*	8.50 /	11.00
Liquid dispersions 40% HT, MT, LT	*lb.*	4.20 /	4.40
35% HT, MT, LT	*lb.*	3.20 /	3.85
30% HT, MT, LT	*lb.*	3.15 /	3.30
25% HT, MT, LT	*lb.*	2.65 /	2.75

Polyethylene

Marlex 50, natural	*lb.*	.47 /	.50
plain	*lb.*	.53 /	1.10
black	*lb.*	.495 /	.575

CALENDAR of COMING EVENTS

October 30
Reinforced Plastics Group, SPE New York Section. Tufaro's Restaurant, Corona, L. I., N. Y.

November 6
SPE Western New England Section. Betty's Towne House, Agawam, Mass.

November 7
SPE Miami Valley Section. Golden Lamb, Lebanon, O.

SPE Southern California Section. Scully's Restaurant, Los Angeles, Cal.

November 10
SPE Chicago Section. Western Society of Engineers Bldg., Chicago, Ill.

November 11
SPE Regional Technical Conference. Hotel Ambassador, Los Angeles, Cal.

November 17
SPE Pacific Northwest Section. The New Grove, Seattle, Wash.

November 17-21
SPI Eighth National Plastics Exposition. International Amphitheatre, Chicago, Ill.

November 18
SPE Upper Midwest Section. Worma's Cafe. Minneapolis, Minn.

SPE Southern Section. Architects and Engineers Institute, Atlanta, Ga.

November 21
SPE Pittsburgh Section. Cappy's Restaurant, Pittsburgh, Pa.

SPE Rocky Mountain Section. Denver Athletic Club, Denver, Colo.

SPE Southeastern Ohio Section. Berwick Hotel, Cambridge, O.

December 1-6
ASME annual meeting. Statler and Sheraton-McAlpin Hotels, New York, N. Y.

December 10-11
Eigth SPI Film, Sheeting, and Coated Fabrics Division Conference. Commodore Hotel, New York, N. Y.

December 11-12
National Construction Industry Conference. Congress Hotel, Chicago, Ill.

January 28-31
SPE 14th ANTEC. Sheraton-Cadillac Hotel, Detroit, Mich.

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Domestic Production and Sales of Plastics and Resin Material, May and June, 1957

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of May and June, 1957. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Summer always seems to be the slow season—vacations, entire plants close down, the Christmas rush is not yet on. Who wants to slave over a hot press, injection machine, or extruder? So it was in June of 1957—but it still showed that steady increase when figures are compared with June, 1956.

	May, 1957		June, 1957	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.03 gage	1,510,191	1,527,265	1,795,547	1,756,065
Sheets, 0.003 gage and over	1,585,234	1,570,160	1,569,561	1,577,817
All other sheets, rods, and tubes	562,254	585,020	728,923	599,226
Molding and extrusion materials	7,672,481	7,511,843	7,793,884	7,432,770
Nitrocellulose sheets, rods, and tubes	412,186	375,579	269,720	294,840
Other cellulose plastics	465,567	481,027	468,077	421,610
TOTAL	12,207,913	12,050,894	12,625,712	12,082,328
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	15,559,098	16,451,848	13,876,755	13,384,129
Bonding and adhesive resins for—				
Laminating (except plywood)	5,170,518	4,314,076	4,986,333	3,622,693
Coated and bonded abrasives	1,859,965	1,623,722	1,012,725	967,134
Friction materials (brake linings, clutch facings, and similar materials)[7]				
Thermal insulation (fiber glass, rock wool)	4,038,888	4,199,208	4,644,865	4,262,815
Plywood	4,428,255	3,534,281	4,012,367	2,842,857
All other bonding and adhesive uses	5,164,081	5,098,659	4,781,306	4,586,172
Protective-coating resins, unmodified and modified except by rosin	3,071,982	2,163,224	2,431,019	1,992,315
Resins for all other uses	3,030,053	2,502,042	3,000,715	2,581,266
TOTAL	42,322,840	39,887,060	38,746,085	34,239,381
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,368,053	2,910,580	2,338,040	2,373,011
Paper-treating and Paper-coating resins	1,888,277	1,909,536	2,318,053	2,056,571
Bonding and adhesive resins for—				
Plywood	8,491,768	7,837,384	6,948,201	7,433,543
All other bonding and adhesive uses, including laminating	1,911,896	2,369,833	3,038,431	2,334,118
Protective-coating resins, straight and modified	2,956,604	2,087,831	2,910,985	2,375,101
Resins for all other uses, including molding	8,310,893	8,133,992	7,293,189	6,522,095
TOTAL	26,927,491	25,249,156	24,846,899	23,094,439
Styrene Resins:				
Molding materials[1]	35,321,842	33,014,539	31,393,584	24,177,628
Protective-coating resins, straight and modified	7,389,264	7,644,055	5,550,273	5,201,314
Resins for all other uses	13,276,171	10,929,903	11,947,941	8,470,007
TOTAL	55,987,277	51,588,497	48,891,798	37,848,949
Vinyl and Vinyl Chloride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		7,641,421		7,097,639
Sheeting (resin content)		3,764,902		3,860,561
Molding and extrusion (resin content)		18,218,169		17,195,249
Textile and paper treating and coating (resin content)[2]		4,628,023		4,688,044
Flooring (resin content)		7,518,599		6,245,311
Protective coating (resin content)		3,227,494		2,361,873
All other uses (resin content)		4,388,412		3,791,340
All other vinyl resins for—				
Adhesives (resin content)		3,404,008		4,467,057
All other uses (resin content)		10,371,166		9,851,159
TOTAL	71,363,023	63,162,194	67,280,384	59,558,233
Coumarone-Indene and Petroleum Polymer Resins	23,586,127	23,855,958	17,082,997	18,072,026
Polyester Resins	8,525,310	8,392,778	8,177,872	7,199,292
Polyethylene Resins	56,170,090	59,504,001	56,073,589	51,036,661
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1], [4]	3,731,226	3,637,763	3,491,495	3,425,419
Protective-coating resins[5]	940,301	599,314	1,008,151	498,718
Resins for all other uses[6]	11,386,998	9,643,335	11,322,573	9,559,399
TOTAL	16,058,525	13,880,412	15,822,219	13,483,536
GRAND TOTALS	313,148,596	297,570,950	289,547,555	256,614,845

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

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